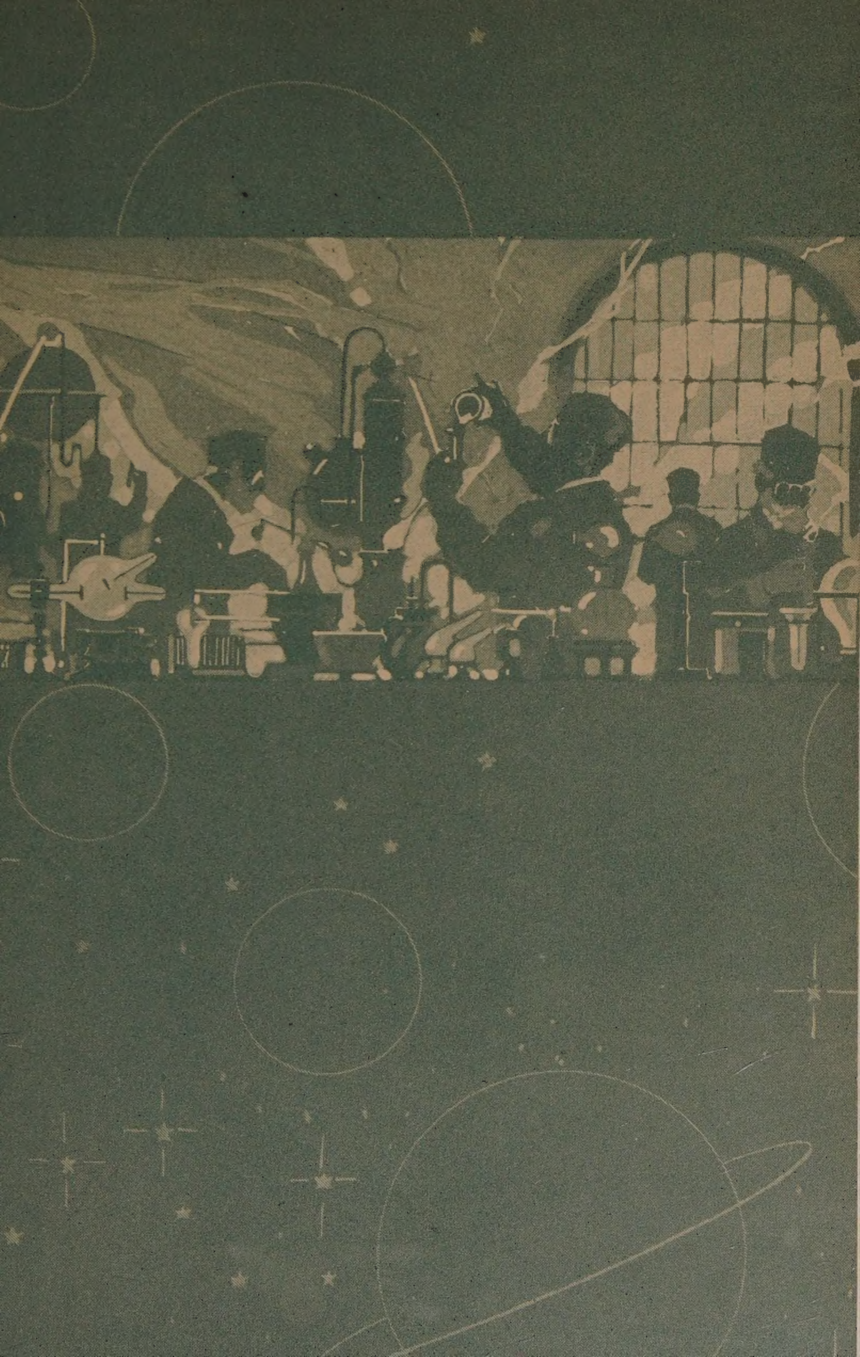

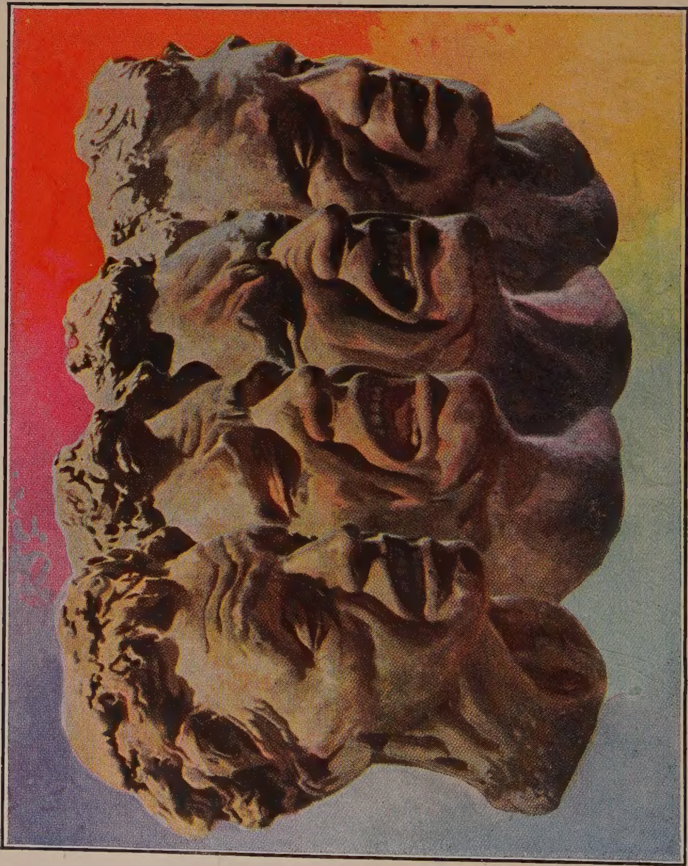

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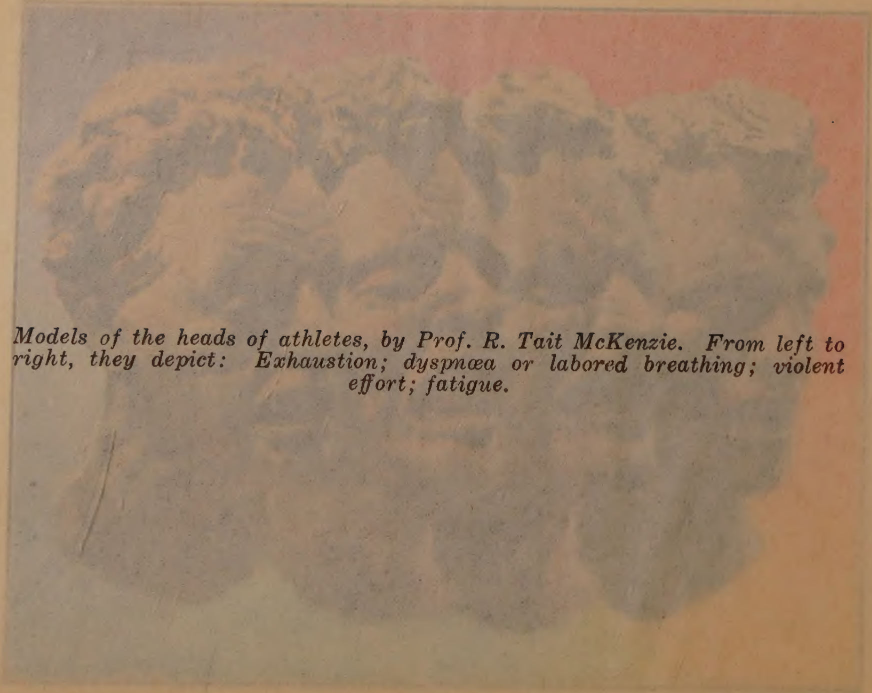

Models of the heads of athletes, by Prof. R. Tait McKenzie. From left to right, they depict: Exhaustion; dyspnœa or labored breathing; violent effort; fatigue.

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WITH A HISTORY OF SCIENCE, GLOSSARIES
AND A GENERAL INDEX

SUPPLEMENTED BY A LOOSE-LEAF VOLUME EMBODYING
THE MOST IMPORTANT DEVELOPMENTS IN SCIENCE,
ANNUALLY, FROM 1923 TO 1932

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PSYCHOLOGY

The Science of Human Behavior

BY

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Professor of Philosophy and Psychology
Tufts College

P. F. COLLIER & SON COMPANY
NEW YORK

PREFACE

THE widespread popularity which the science of psychology has achieved is justified both by the practical and the cultural rewards which it has provided. "*Know* thyself," said Socrates, the founder of occidental civilization, and his maxim still keeps its potency as a stimulus to profitable endeavor. "The proper study of mankind is *man*," said Alexander Pope in imitation of Socrates, and modern psychology has verified the truth of his remark. It is consequently in no sense of the term an innovation for this book to be called the Science of Human Behavior.

Psychology, then, is concerned with much more than man's thoughts. It concerns his entire nature. If the psychologist studies the human mind, he also investigates the part which the human body plays in causing and regulating mental phenomena; if he studies thoughts and feelings, he also inquires how that marvel of nature's ingenuity—the human brain—provides the machinery by which thoughts and feelings are generated. Indeed, since the modern point of view in psychology is that mind is strictly a function of the human body, no true psychology is possible without some knowledge of physiology—a knowledge which this book undertakes to provide for the most elementary reader.

This book might be called a composite photograph of modern psychological tendencies, as is evidenced by its many quotations from the writings of prom-

inent teachers of this science. Let me, then, acknowledge my indebtedness to Dr. Edwin Holt, (formerly of Harvard University); to Dr. George W. Crile of the Lakeside Hospital in Cleveland; to Professor E. B. Tichener, of Cornell University; to Professor W. B. Pillsbury, of the University of Michigan; to Professor William McDougall, of Harvard University; to Dr. Percy Stiles, of the Harvard Medical School; to the late Professor William James; and to other writers and teachers of psychology and physiology whose works are quoted in my pages.

CONTENTS

CHAPTER		PAGE
I.	Introduction	9
II.	Structure and Functions of the Brain	15
III.	The First Things We Learn To Do	33
IV.	The Rôle of Instinct in Mental Life	46
V.	The Motors of the Body	57
VI.	Sensation: Its Nature and Varieties	62
VII.	Hunger and Thirst	65
VIII.	Taste and Smell	69
IX.	Vision	83
X.	Hearing	98
XI.	Touch, Warmth, Cold, Tickle, and Itch	109
XII.	Pain and Pleasure	116
XIII.	The Sense of Motion and the Touch Blends	123
XIV.	Emotion	129
XV.	The Sentiments	143
XVI.	Reaction Types and Reaction Times	152
XVII.	The Perception of Space	160
XVIII.	The Perception of Time	192
XIX.	Association	197
XX.	Memory	208
XXI.	Imagination	218
XXII.	Attention	228
XXIII.	Reasoning	237
XXIV.	Habit	247
XXV.	Will	259
XXVI.	Fatigue	268
XXVII.	Sleep	281

CHAPTER		PAGE
XXVIII.	Dreams	292
XXIX.	Suggestion	303
XXX.	Hypnotism	311
XXXI.	The Mind of the Crowd	323
XXXII.	Salesmanship	334
XXXIII.	Advertising	343
XXXIV.	Wit and Humor	350
XXXV.	Industrial Psychology	358
XXXVI.	Mental Hygiene	368

LIST OF ILLUSTRATIONS

Facial Expressions of Athletes Caused by Effort and Weariness . . . . *Frontispiece*

FACING PAGE

Test of the Sense of Rhythm 32
Emotional Reaction to Pictures and Colors . . . 32
Test of Muscular Control and Coordination . . . 33
Test in Orientation, After Whirling 64
Test of the Sense of Equilibrium 65
Blending of Colors to the Sense of Sight . . . 96
Testing Field of Vision and Color Zones of the Eye 96
Testing Perception of Differences of Length . . 97
Test of the Sense of Hearing in Judging Distance 160
Testing the Degree of Emotion 161
Registering Elapsed Time Between Signal and Response 192
Test in Judging Weight 193
Test for Fatigue and Endurance 224
Exhaustion of an Athlete 225
Difficult Breathing as the Result of Efforts in a Race 225
Portrait of Professor William James 252
Attitude of Attention 253
Runner When Fresh, Before Beginning a Race . 272
Same Runner After a Race, Showing Effects of Exhaustion 272
Runner's Violent Effort Before Winning Victory 273

FACING PAGE

Subnormal Types, as Shown by Feathers and Facial Expression 320

Blending Two Pictures in One—A Trick of Vision 321

Tests in Industrial Efficiency—Hammering Equal Spaces 352

Tests in Industrial Efficiency—Tapping with Pencil 352

Tests in Industrial Efficiency—Firmness of Hand 353

Tests in Industrial Efficiency—Steadiness of Hand 353

CHAPTER I

INTRODUCTION

TO psychology belongs the peculiar distinction of being everybody's science. For since every human being has a mind, the science which deals with mental phenomena must have a peculiarly intimate and constant relationship to him. No other science can possibly have such a universal human appeal. It is true that we all have somewhat to do with physics—seeing that we live in an environment of physical objects—and we are also now and then obliged to take account of the data of chemistry, biology, astronomy, and of some of the other sciences. But psychology is particularly distinguished as that science whose facts and laws we are perpetually exhibiting. We may close our eyes and shut out most of the physical world, but there is no such door which we can close on the mental world.

Whether we will or no, then, we are all interested in the science of psychology. We may not yet have organized our knowledge of the workings of our mind into anything like a true science, and we may still be unaware of how cause and effect operate to produce our thoughts and feelings, our ambitions and sorrows, but in spite of all this we are all at least amateur psychologists. For since our minds are the only means we possess wherewith to gain experience, and since we are constantly using our minds by night as well as by day, psychology is our

chief concern. Do we succeed or fail in some cherished undertaking? It is because we have applied the psychology we know profitably or otherwise. Can we make or keep friends, or do we find ourselves at middle age bereft of agreeable companions? It is because we have applied our psychological information well or badly. Indeed, our important plans and projects, our business schemes and interviews, our investments of money and friendship, are one and all examples of applied psychology.

It would seem, then, that a scientific study of this field of human interest would be extremely profitable. We need to do more than "muddle through" our psychological problems; we need to know the most intricate workings of the mental mechanism in order not only to save the time and energy we now waste in guesswork, but also to direct our ambitions and plans in the most profitable manner possible. In this respect psychology is like all the other sciences. For just as a scientific study of the physical world and of the chemical world and of the world of mechanics and geology arose out of an ambition to control and manipulate the physical environment, so the chief motive underlying the scientific study of psychology was a desire to employ the mind to the greatest possible advantage. "Knowledge is power," said Francis Bacon, "power for the benefit and use of men." The study of psychology furnishes just such power; it is the most profitable investment a man can make.

Psychology is commonly defined as the science of mind, or of consciousness, or of human experience. Such definitions, while admirable for their brevity and compactness, do not explain the matter sufficiently, nor do they sharpen our curiosity to investi-

gate any further. All these terms—mind, consciousness, and experience—are too vague and general for our purpose. Besides, they lead us to suppose that because each man has a mind, a consciousness, and an experience, he has therefore a scientific acquaintance with them. This is, of course, not so. In addition, many of our experiences flatly contradict each other and so make it impossible for any scientific value to be attached to them. "One man's meat is another's poison," runs the old saw. The motto, "Too many cooks spoil the broth," is opposed by the maxim, "In the multitude of councilors there is safety." Psychology is not merely a nodding acquaintance with mind or experience; it is rather a study of how mind develops, and under what conditions it prospers or decays; of how consciousness originates, as well as why it is often alternately clear and cloudy; and so on. The psychologist does more than admit the existence of his mind, his consciousness, and his experience. In order to attain the knowledge that is power he seeks to explain these various phenomena in all their minute details.

From this it is apparent that no tabloid definition of psychology can be supplied. The field of the science is too large and complex to be passed over so briefly. Nevertheless, we may say that psychology deals with all such things as thinking, feeling, and acting; with memory, forgetting, intending, and resolving, with how things get known by us, and how they get organized into our available knowledge. It deals with pleasure and discomfort, fear and joy, and all the host of emotions and sentiments; with walking and running, fatigue and sleep, honesty and treachery, skill and imbecility, and every other kind of human excellence and failing. In brief, *psychol-*

ogy is the science of human activity in its largest and most pervasive sense. For mind is in the last analysis *action*—the action of human beings in the midst of their environment. Some of this action we call sense-perception, some we call thinking, some we call feeling, some we call skill, some we call imagination, and so on throughout the long list of mental powers and functions.

If mind is activity, we may well ask the question: "Of what is it the activity?" It would be absurd to reply that "Mind is the activity of our mind." Only the feeble-minded speak so. And while it will require the first half of this book to explain fully just what mind is, we may venture here to say that *mental activity is a combination of physical, chemical, and electrical energies developed by the nerves, muscles, and glands of the human organism.* It is a study of the how and the why of thinking, feeling, and doing, and it explains these processes in terms of the dynamos and motors of the human body—its brain, its muscles, and its glands. It is not our mind that does our thinking, but it is the sum of our thinkings, feelings, and doings that is our mind. And this vast collection of mental activities, this novel, subtle, and intricate assemblage of energies is generated by the human body as the result of its immediate contacts with the environment in much the same way as electricity may be generated by a turbine that has been placed in the midst of a tumbling waterfall. In Sherrington's striking words: "Environment drives the brain, and the brain drives the rest of the body."

When, then, we shall speak in the following pages of mental mechanisms, let it be well understood just what is meant. We shall mean by the word mecha-

nism some apparatus of the body (always including nerves and muscles, and sometimes in addition involving glands) for the purpose of transforming the common energies of nature into the special energies known as mental. A bowl of soapsuds is a mechanism for making bubbles, two sticks of hardwood are a mechanism for making a fire, and a cookstove with a flue and a damper is a mechanism for making biscuits. In the same way the special structures in the body known as sense organs, brain, muscles, and glands are mechanisms for producing skill, thought, memory, ambition, and the like. For since we always find minds in connection with bodies, we are convinced that these various special bodily structures are essential for the development and integrity of the mind.

This conviction that mind is dependent on bodily activities has the finest kind of support. To begin with, as we ascend higher in the scale of life and intelligence, we find an increasingly higher and more complex nervous organization. Second, brain defects, such as decay and wounds, give rise to mental incapacities. Third, poisons affecting the body also impair the mind. Fourth, fatigue of the body gradually dulls the mental capacities. Fifth, the "speed of thought" has been identified with the speed of the nervous current. And so on throughout an extended list of scientific discoveries which reveal to us many of the intimate secrets of our physical and mental existence.

Let it not be supposed, however, that the term "mental mechanism" is at all materialistic. Materialism identifies matter and mind completely, while mechanistic psychology simply calls mind *activity.* The difference between the two conceptions is pro-

found. Materialism denies the existence of mind, while mechanistic psychology merely seeks to explain it by the most obvious and convenient means which ten centuries of patient scientific investigation have placed at our disposal.

In this book we shall deal principally with normal human psychology. We shall touch but little upon the abnormal and the morbid. The psychology of infancy, childhood, old age, genius, and the like must also be left out of our account. Nevertheless, to make up for this incompleteness, whenever possible, we shall treat of the applications of psychology to the various interests of human life, showing why and how a knowledge of the laws of mental phenomena makes for a wider, richer, and more comfortable life. Let us then at once turn to an examination of how the mechanisms of the brain serve to transform the common energies of nature into the special energies of mind.

CHAPTER II

STRUCTURE AND FUNCTIONS OF THE BRAIN

THE brain is the great central telephone exchange whereby both vital and mental functions—life and thought—are regulated. It is not the brain in which either life or thought originate, but only where the organization of vital and mental functions is finally perfected. The central office of a telephone system does not originate the conversations which are carried on by the subscribers, but merely furnishes the interconnections and the electric current whereby such conversations may be carried on. Likewise the brain, highly important as it is for the body and mind of man, is not the fountain and source of his life or his intelligence, but it is rather the instrument whereby his many energies may be guided and combined and brought into harmonious and profitable relations with one another. Every cell of the body is alive and brimming over with chemical and electrical energy; every cell of the body is also vaguely or blindly sentient, seeking in some way to grow, to persevere, and to reproduce; but without the brain to unite, harmonize, and render mutually democratic all of these myriad striving units the body would be chaos, lacking that unification and direction which go by the name of mind.

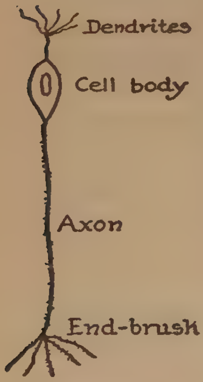
Now, just as the central telephone exchange turns out upon close inspection to be a great mass of

switchboards, with wires and plugs and batteries and rheostats, the sole purpose of which is to connect the subscribers with one another in order that the desired communications may be established and maintained, so the brain is simply a great gray-and-white mass of tiny nerve fibers in intricate but orderly arrangement for the purpose of furnishing the necessary connections both between the various vital organs of the body and between the body and its environment. Each is housed in its own building—the telephone exchange in brick or stone or wood, the brain in its skull. And just as from the telephone building great masses of wires run in a lead pipe or conduit to lesser distributing points, so from the brain proceeds a large mass of nerve fibers—the spinal cord—down through a channel in the backbone to the base of the spine, giving off at every joint of the vertebral column bundles of tiny nerve threads to the different areas and centers of the human body. Every last element of the brain—which together with the spinal cord and its tributary branches we call the central nervous system—is a mechanism for communication. Let us examine one of the elements of this communicating mechanism in detail.

No matter how intricate a piece of tapestry may be, with its trees and flowers and the pastoral or battle scenes it depicts, if you unravel it and pick it to pieces, it will be found to be made of many colored threads, some long and some short, but all of them nevertheless threads. Such finally indivisible parts are called the *structural units* of the tapestry. Similarly, if the central nervous system were to be teased apart, we should be able to isolate its structural units in the same manner. Owing to their extreme small-

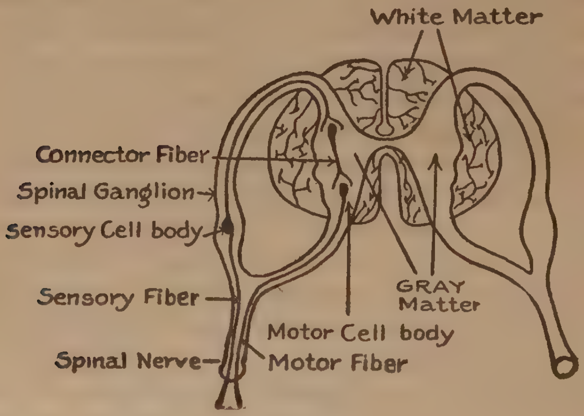
ness, these tiniest parts of the nervous system cannot be isolated by hand, but with the aid of a high-power microscope they can be readily seen in all their minute detail. Such structural units of the nervous system are called *neurones*, of which there are in the human body some eleven thousand million.

These neurones are of various lengths and shapes, but they are all storehouses of energy and pathways of communication. The typical neurone is perhaps best described as a long, white fiber, somewhere along the course of which a roundish gray mass, the nerve cell body, is located. Physiologists regard the cell body as the more important, since it is the nutrition center of the neurone, but for psychology the fiber along which the nervous impulse passes is the more highly significant part. If the darkest central portion of the cell body—the nucleus — dies or is removed, the whole cell, together with the fiber, dies and is forever lost to the body; but if only the fiber is injured or cut, it will usually grow out again. Such growth is accomplished by the very delicate sheaths which surround the fiber, which serve both to nourish and to insulate it. What is popularly called a "nerve" is a cable composed of thousands of these tiny fibers. And just as in a telephone system there are hundreds of fine copper wires, each insulated from one another to prevent the loss of current and short-circuiting, so in the nervous system each neurone fiber is insulated by its two sheaths called respectively the *myelin* sheath and the *neuri-*



NEURONE

lemma. And, finally, just as in the telephone system all the wires run clear to the central office before a connection is made, no matter how close together the subscribers may live, so in the human body all the



THE BRAIN

nervous impulses run first into the central nervous system by one fiber and out of it by another before sensation, feeling, or thought takes place.

FIVE FUNDAMENTAL LAWS OF NERVOUS ACTIVITY

We may now speak of the connections between neurones. It is customary to regard each neurone as structurally distinct from all the rest, but *functionally,* that is, when regarded as part of a mechanism for transmitting impulses and transforming energy, it always coacts with other neurones. The neurone fiber branches at either end, or *arborizes,* into many delicately fine strands. One such set of terminations is called the *dendrites,* the other the *end-brush.* And this brings us to the first law of nervous activity, which is, that *the nervous impulse*

always travels from the dendrites down the fiber to the end-brush. This direction is irreversible unless the nerve be taken out of the body to be experimented upon in the laboratory. In other words, as soon as you know where the dendrites are, you know where a nervous impulse will begin, and also what direction it must take.

Obviously, then, if the flow of the nervous current is always in this one direction, *all sense organs,* from which stimulations are received, such as the eye and the ear, *must be connected with dendrites.* This, indeed, is exactly the case. No matter what we feel in the way of sensation—color, smell, cold, or nausea —it is due to a stimulus which has started a nervous impulse at a dendrite. Where now does this impulse proceed? It follows up the fiber, through the nerve cell body, along the remainder of the fiber (called the *axon*) to the branched end-brush where that particular neurone ends. But at that point another neurone begins. The end-brush of the first neurone interlaces with the dendrites of a second, and across this tiny but actual gap the impulse leaps just as a spark leaps across the terminals of an electrical machine, and proceeds up neurone number two to its end-brush, across to the dendrites of a third, and so on to a fourth, a fifth, a sixth, and perhaps even to a hundredth such neurone, until it finally reaches the end of its journey where the last end-brush terminates in a muscle which is set into contraction. When the eye winks and waters to wash out dust, such a pathway of sense-organ, neurones, and muscle is set into activity; when we sneeze to drive out dust the same elaborate activity takes place; and, as will be presently shown, even when thought and feeling occur, the same sort of nervous mechanism has been

involved. Only, in thought and feeling, the action is less obvious to the onlooker, but in every case the telephone system of the brain and spinal cord has made its connections and transformed the common energies of nature into the special energies of mind.

The speed of the nervous impulse is, according to the most refined methods of measurement, 123 meters per second. But this rate holds only for the single neurone. For the gap between the neurones (technically called the *synapse*) often retards the passage of the impulse. It is retarded in fatigue, in doubt and deliberation, in sleep and under the influence of anæsthetics. Accordingly, we may state the second law of nervous activity, that *all retardation of the nervous impulse occurs at the synapses.*

The pathway we have just been describing, involving sense organ, nerve, and muscle, is called a *reflex arc,* and is the *functional unit* of the nervous system. All mental activity involves such reflex arcs. The simplest arcs are connected with what are called simple reflexes or reflex actions, such as sneezing, coughing, winking, withdrawing one's hand from contact with a hot or sharp object, and the like. All such acts are absolutely automatic. More complex nervous arcs are involved in such things as instincts, still more complex in learning, and the most complex of all (sometimes involving thousands of nervous elements) in our intelligent planning and deliberation. The higher we go in mental activity, the more of the nervous system do we find involved, and usually, also, the greater delay before the final discharge of nervous energy.

While all neurones are of the same substance chemically, and have the same appearance under the microscope, they have not all the same functions.

Those which have their dendrites in contact with a sense organ are called *sensory* neurones, or *receptor* neurones. Those which lie entirely within the brain or spinal cord, and connect there with the end-brushes of the receptor neurones, are called *connectors;* while those which reach out their long axones, tipped with end-brushes, to connect with muscles and glands, we call *motor* or *effector* neurones. A reflex arc is therefore made up of receptor, connector, and effector fibers. The brain is almost wholly made up of connector fibers, most of which are relatively short. This means that within the brain there are millions of synapses, from which it also follows that most of the delays to action, especially the delays during pondering and deliberation, take place at the synapses within the brain.

We have all seen people so completely surprised by some event or thing as to be apparently mindless for an instant or so. This illustrates a third important law of nervous activity, which is that *when a reflex pathway has been too strongly excited it is incapable of a second excitation within its own period of recovery.* This period is called the "refractory period" or "refractory phase." All physical nature shows examples of the very same thing. A printing press can be overworked, soil needs to recover from crops, and fountain pens write better if left to recover after long and continued use. The human body, and especially the nervous system, is no exception to this rule.

Another and fourth law of nervous activity is the law of summation. *If several very weak stimulations be given to a sense organ, none of which are capable of producing a nervous discharge, these stimulations will, if repeated sufficiently, finally sum*

up into a full excitation. We may not notice the first drop of rain or the first jingle of the telephone bell, especially if we are preoccupied, but continuous dropping of rain and prolonged jangling of the bell finally get noticed. Similarly, though white gloves perhaps begin to soil the moment they are put on, it is not until they have been worn for a while that we notice the smudges that have accumulated. It is likewise this law which explains why a very dull person may require many hints from his lady love that his visits are not desired or his ambitions reciprocated.

A fifth and final law may now be stated. It is the law of *the final common path.* We have already seen that the nervous arc requires at least three neurones: the receptor, the connector, and the effector or motor fiber. But there are far more connector than receptor fibers in the body, and far more receptors than effectors. This would imply that, unless several receptor and connector fibers finally connect with the dendrites of one motor fiber, there would be no means provided for those fibers to produce reflex action. No such difficulty is present. *The use of one motor fiber by several receptor fibers is universal, and the final motor neurone of the chain is called the final common path.* This enables great economy and efficiency to be obtained. The law of the final common path is illustrated by us in every case in which different stimuli call forth the same response from us. Pepper, lint, and dust (varying stimuli) look alike (identical response). During the late war in Europe all Germans (varying stimuli) were called "Huns" (identical response). The law has far-reaching applications. The Greeks called all foreigners indiscriminately "barbarians," and

the Latin word for stranger was "enemy." But we may even detect the working of this law every time we use a common noun in speaking. For the words "horse," "tree," and "boat," and the like are employed, not merely to designate *one* such object, but many and various ones, and this means that many different sensory and connector neurones have been functionally united to one final common motor pathway leading to the speech mechanism by which such a word is uttered. Obviously the more general and abstract terms of speech, such as "virtue," "wisdom," and "beauty," have had a similar origin. Indeed, all scientific laws by which natural phenomena are classified and unified owe their existence to the principle of the *final common path*.

MIND AS THE SUM OF OUR REFLEX RESPONSES

We have already spoken of the nervous system as an instrument for communicating impulses and transforming energy. We may now make the statement that the nervous system is a mechanism for the release of energy in response to sensory stimulation. The reflex arc then becomes an instrument for reflex response. If a particle of dust gets into the eye, that organ and the nervous, muscular, and glandular apparatus connected with it winks and washes out the offending dust. The winking is muscular response, while the tears are the result of the response on the part of the lachrymal gland. The postman's whistle stimulates our ears, and we rise and walk (muscular response) to the door. The fire bell clangs (auditory stimulus), and the man who forgot to renew his fire insurance (blockades at the brain synapses) looks startled and gets a rise of blood pressure (muscular and glandular responses).

And so on throughout the list of all our mental activities. If, then, we were to put into a ten-word telegram the best short-cut definition of mind, we should say: "Mind is the sum total of man's responses to environment." The environment without? Not always; for sometimes the nervous system responds to an environment that is strictly within us, as, for example, in headache following eyestrain, or in dreams which rarebit suppers have provoked.

Such responses, of course, involve an expenditure or release of energy. When glands are stimulated, the release of energy is exemplified in the chemical output of the gland which drains the body's resources for the time being. The tear gland releases energy by secreting tears, the salivary gland by the production of a flow of saliva, the stomach by producing a stream of gastric juice, and so on. In every such case the motor nerve, terminating in an end-brush, is embedded in the cells of the gland, and the nervous current—an electrochemical wave of energy—simply starts the glandular mechanism going.

The release of energy by means of the muscles is otherwise accomplished. The food we eat contains sugars of various sorts, known as carbohydrates, which the blood stream takes directly to the various muscles of the body in which it is stored. Now, the end-brushes of the motor nerves are distributed within the muscles, and each tiny nerve fibril is fastened to a single muscle fiber. When the wave of electrochemical energy passes down the motor nerve and into the mass of the muscle, it stimulates it to contract while at the same time it produces a chemical action there. This chemical action is the transformation of some of the stored carbohydrates into lactic acid. The nervous current here, then, produces

not only a mechanical but a chemical energy transformation as well. The blood stream which brought the carbohydrates from the intestines also brought oxygen from the lungs for the purpose of restoring the muscle to normal again. The lactic acid produced by the muscular contraction is now carried out by the blood stream and eliminated by the kidneys. Since all muscular action involves both the production of heat and of chemical energy, we may now regard these two things as essential for the production of sensation, feeling, and thought. Those responses to the environment which we have collectively called mind are, then, truly *activities*, but activities indeed of a very novel kind, involving the most elaborate electrical, chemical, and mechanical devices of which we have any knowledge.

It is obvious from the foregoing that, since all mental activity involves such an expenditure of the body's energies, sensation and thought are costly to maintain. Fatigue, inattention, and sleep bear witness to this expense. Needless to say, all applied psychology begins with the need for an economic use of all our mental energies.

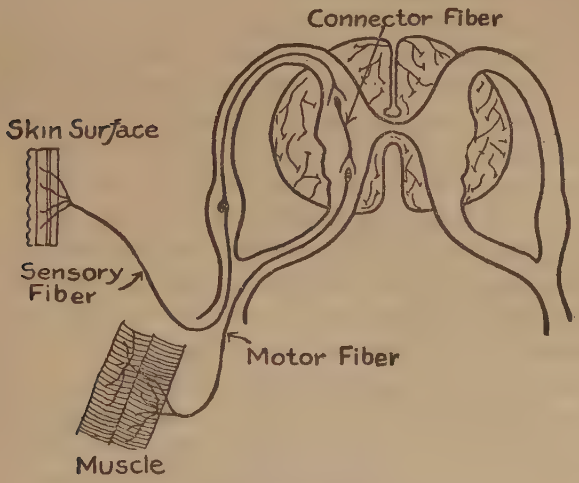
THE FUNCTIONS OF THE SPINAL CORD

The spinal cord is a long cable of nervous tissue leading off from the brain, and distributing bundles of fibers to all parts of the body. It is the principal mechanism for automatic reflex actions. Along its course from the brain downward it gives off thirty-one pairs of nerve-bundles called the spinal nerves, which branch and terminate all over the body. Each pair supplies a fairly definite region of the body, the upper spinal nerves supplying the head and neck, the next lower group the arms, the next the chest

and abdomen, and the lowest the legs. The arrangement is symmetrical—the palms of both hands, for example, being supplied by the same pair of spinal nerves. Each spinal nerve contains two kinds of fibers and two only: receptors and effectors. And here we may make a very clear distinction between these two sorts of nerves for the whole body. *The cell bodies of all effector nerves whatsoever lie entirely within the mass of the central nervous system, while the cell bodies of all receptor nerves whatsoever lie entirely outside the central nervous system.* The presence of these receptor cell bodies may be detected even with the naked eye. Just before entering the cord each spinal nerve branches. The receptor branch enters the cord at the rear (or posterior part), the effector branch enters it by the front (or anterior portion). The receptor branch is marked clearly by a bulblike thickening, called a ganglion. This thickening is due to the presence of cell bodies, which, as we have already said, are larger than the nerve fibers. The fibers continue from these ganglion cells into the cord, where they arborize around the cell bodies of conductor and effector fibers. The spinal cord is white on the outside and gray within. The gray appearance is due to the presence of nerve cell bodies there. The cells within the cord are arranged in a definite pattern which, when the cord is cut across, looks like the letter H. The effector or motor cell bodies are all situated in the anterior portion of this H-shaped pattern. All the other cell bodies in the gray matter of the cord are the cell bodies of connector neurones.

How, then, is some simple spinal reflex action performed? If we tickle the sole of the foot of a sleeping man, he moves the leg to withdraw the foot from

the stimulus. The impulse proceeds up a long receptor neurone reaching from the sole to the lower spine, passes through the cell body of that neurone in the ganglion just outside of the cord, and thence into the cord, where the impulse crosses the synapses between the receptor fiber and the motor fiber of that particular reflex arc. It then proceeds out by the motor pathway and down the leg again to the



SIMPLE REFLEX ACTION

muscles which contract to bend the knee and lift the foot away from the source of the tickle. The spinal cord functions in the same way when we sneeze, cough, swallow, breathe, digest, eliminate waste matter, yawn, walk, and perform a hundred other unconscious and semiconscious actions. And here we may introduce a new principle of nervous activity, which is that, *unless a complete nervous arc is traversed, there is neither action nor consciousness as the result of stimulation.* This principle is

also the basis of the bromidic maxim, "What you don't know won't hurt you," i. e., that since without motor response there is no consciousness, there can be no mental disturbance either.

THE HIGHER NERVOUS CENTERS: THE MEDULLA, THE CEREBELLUM, AND THE CEREBRUM— THE SWITCHBOARDS OF THE BRAIN

At the upper part of the spinal cord the nervous system vastly increases both in size and complexity. The cord thickens at the neck, where it is called the *medulla*, and there it is connected with the *cerebellum* (little brain) and *cerebrum* (great brain). But in spite of the great and bewildering complexity of pathways which here confronts us, the ultimate functions of these parts are identical with those of the cord neurones. The architecture of this part of the nervous system comes in for its full share of descriptive terms, some of which are highly fantastic. Such names as bridge, worm, olive, aqueduct, ventricle, island, fissure, sooty wing, triangle, tongue, roof, horn, fold, leaf, tooth, pyramid, sail, vestibule, spur, floor, tail, and the like, may serve to illustrate the tremendous complexity of this wonderful, automatic telephone system. The important thing for psychology, however, is not the complexity of the brain, but only its functions. And these functions may be best studied in connection with the system of switchboards in these higher nervous structures sometimes called the sensory and motor centers, or areas, of the brain.

These switchboards are really ganglia, the same in structure and function as the spinal (receptor) ganglia lying outside of the cord, and the gray H-shaped collection of cell bodies in the center of the

cord. In the brain these ganglia are termed *nuclei* (singular *nucleus*). These higher switchboards serve both to connect the cranial nerves with one another, and to connect the cranial nerves with the spinal cord. These cranial nerves are concerned with the special senses, and are, like the spinal nerves, grouped in pairs—twelve on a side in strikingly symmetrical arrangement. Only two of these cranial nerves lead directly to the cerebrum proper; all the rest lead either to the medulla or to the mid-brain stem, a thick, short bundle of fibers which connects the cord with the cerebrum.

The brain is not only full of wrinkles (convolutions) on its surface (where most of its cell bodies are located, giving it the characteristic gray color), but it is also marked on the outside by deep clefts (fissures), and within by caverns (or ventricles). The convolutions and fissures provide a more extensive surface for the cell bodies than could be supplied if the brain were smooth. The ventricles within are filled with a fluid known as the cerebrospinal fluid. It is the elasticity of this fluid which protects the brain from damage inflicted by blows upon the skull. The ventricles are curious and elaborate, and connect with one another and with a small canal which runs down the middle of the spinal cord. The *fourth ventricle* is a lozenge-shaped cavern located between the medulla and the cerebellum. Here or hereabouts ten of the twelve cranial nerves have switchboards or nuclei of various shapes and sizes. Only two of the cranial nerves, the olfactory and the optic, run directly into the cerebrum proper. This, however, does not mean that the ganglia of the receptor nerves of smell and sight are in the brain, for we said explicitly before that

all receptor neurones whatsoever have their cell bodies outside the central nervous system. The cell bodies of the receptors for smell and sight are no exceptions to this rule. The retina of the eye is the ganglion or nucleus of the visual receptors, and the tip of the olfactory lobe which projects far out from the brain contains the cell bodies of the receptors for smell. *The so-called optic and olfactory nerves are nothing but bundles of connector fibers.* The areas in the brain to which they lead are secondary switchboards, or, as we may now call them, association centers. Likewise the nerve of hearing, the auditory nerve, has its receptor cells in the ear, from which fibers run to the cord to form one switchboard, and thence to the brain to form another.

We shall have to do with all these cranial nerves again in connection with the special senses and with other mental functions. Suffice it here to say that three of them are solely employed to move, focus, and otherwise control the eyes. One of them receives sense impressions from the skin of the face, the tongue, and the teeth by its receptor fibers. One controls mastication with its motor fibers. Another controls facial expression. One of them coordinates impressions and movements in connection with the tongue and pharynx. One of them regulates the contraction of two very important muscles of the neck, which have to do with the carriage of the head and with temperamental poses. The nucleus of this particular nerve lies very near that of the *pneumogastric* or *vagus* nerve, which regulates the heart, stomach, and other parts of the viscera. Mark here how many important functions these ten cranial nerves, all of which have switchboards in and about the fourth ventricle, perform! It is the proximity of

these switchboards, moreover, which makes it possible for one part of the body to get into such direct contact with another. The functions of digestion, of circulation, of facial expression, of hearing, and of articulation, all being regulated by adjacent nuclei, can also influence each other to a marked degree. This is our daily experience. The state of our health shows in our looks and the posture of our head, and our voice often registers our whole bodily tone.

Man walks upright, and hence has to balance himself as he stands or goes. Walking is, indeed, a continuous succession of falling and recovering ourselves. This balance is maintained by the cerebellum. A pigeon deprived of this organ can neither fly nor keep its feet. While it staggers and flutters about, there is no apparent loss of the ability to contract individual muscles, but its equilibrium in both rest and motion is destroyed. The cerebellum is the great instrument for the maintenance of muscular tone and poise.

Although there are, strictly speaking, neither receptor nor motor fibers within the cerebrum or brain proper, yet the cerebrum is *par excellence* the functioner of mind. For the brain is the great switchboard of the whole nervous system which connects every part with every other part. The various brain areas or centers, then, are well compared to those departments of a vast manufacturing concern which regulate its credit, float its loans, audit its accounts, advertise, invent, initiate safety-first methods, and attend to the well-being of the employees. The brain is not, therefore, any the less important because it contains only connector fibers. It is, if anything, more important. The brain contains by far the ma-

jority of all our nervous tissue, whose functions are: first, to store energy whereby responses can be indefinitely maintained; second, to check or accelerate responses; and third, to elaborate, modify, and perfect the refinement of response necessary to the higher thought processes. By means of the brain we store recollections, invent new methods, and perform all those modifications of action which are called reasoning, imagining, comparing, analyzing, and the like.

This must suffice for the present for an account of nervous functions. But let it not be supposed that because we have given so prominent a place to the nervous system, it is only with this part of our bodies that we think or feel. We think or feel, imagine or repine, doubt or scheme, and perform every mental operation whatsoever only when hundreds of mechanisms for the transformation of energy are thrown into operation. Our sense-organs, muscles, and glands, together with the communicating nerves, must all be vigorously employed to produce even the least sign of mental activity. These transformations of electrical energy into chemical and of the chemical energy into heat—such transformations and these alone are, so far as we know, the meaning of the word mental. Mind is response to environment; it is not an entity hidden within the skull; it is rather the name for all the activities except growth and metabolism of which the organism is capable.

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TESTING SPECIAL SENSES AND EMOTIONS. At the left, a test of the sense of rhythm in response to metronome beats. At the right, a test of the emotional reaction to pictures and colors.

A Simple Test of Muscular Control and Coordination. With the eyes closed, one arm performs a different set of movements from those done by the other.

CHAPTER III

THE FIRST THINGS WE LEARN TO DO

THE mental life of man has been appropriately called *one long learning process*. From the first breath we draw until the day of our death we are forever engaged in accumulating experiences of one sort or another, which we subsequently employ, either consciously or otherwise, in every new situation and predicament which confronts us. Every experience also teaches and molds us until, by middle age, we become one great momentum of habit, bias, and proclivity—the accumulation and inertia of previous years.

"I am a part of all that I have met," says Tennyson, referring to the fact that each man is indelibly stamped with the seal of his many environments. But not only is man the product of his environment; he is to a large extent the molder of his environment as well. For even while we are in childhood learning what the world is like, and striving to adapt to the weather and to society, we are also stirred with the ambition to achieve, to surpass, and to control. Besides storing up energy which is expended in the process of responding to stimulation, we also store up a vast quantity of energy which is retained and organized. And this stored energy becomes, as we grow and form habits of thought and action, the unconscious source of our personality and our will. Here, too, learning is exemplified, since each brain

and body cell which thus becomes a storehouse of potential energy goes through a process of becoming coordinated with other cells. For just as our hands acquire the skill necessary to write and to play games, so the minutest tissues of our bodies, in becoming immune to certain disease germs, *learn* to neutralize their influence.

The learning processes of life start long before we are born. They may even begin as far back as the time when the embryo was being shaped and partitioned into sense-organs, muscles, glands, and a nervous system. As early as the second week of embryonic life evidences of the nervous system are present. Indeed, no other permanent part of the body is so clearly marked at this time. The response mechanism of the body is fashioned in a very curious way. The tiny organism exhibits a groove along one side of its surface, which groove ultimately becomes the spinal canal and the brain ventricles. The groove deepens, the side layers overgrow and meet at the top, and the nervous system has begun its existence. About this canal nerve-cell bodies begin to form, which will later become the receptors and conductors of stimulation, and the effector nerves which actuate muscles and glands. Our concern here is chiefly with the receptors and effectors, or, as they are commonly called, the sensory and motor nerves. These elementary nerves, which look very much like young tadpoles with an extremely long tail, are called *neurotomes.* At the same time these are being formed, miniature structures, which will eventually become the muscles of locomotion, are developing just outside the elementary nervous system. These primitive muscle structures are called *myotomes.*

Tendrils from those neurotomes, whose destiny it is to become motor nerves, grow toward the muscles and become attached to them. As the embryo enlarges, and is provided with a skeleton and extremities, the myotomes migrate to all parts of the body trailing their nerve fibers, so to speak, behind them. In this manner all the muscles of the body become connected with the central nervous system. Simultaneously with this development, those neurotomes which are to perform the function of sensory or receptor nerves prolong fine fiberlike processes out from the region of the spinal canal into all the surrounding structures, and either become themselves modified into sense organs or else attach themselves to other sense organs already forming in the various tissues. Even so, however, the mechanism for reflex action, feeling, or sensation is not yet perfected. For while the sensory and motor nerves are all more or less in place, there is no functional connection between them—the disturbance in a sensory fiber has never been transmitted to a motor fiber. Between these two fibers in the cord a network of connector or association fibers must first develop, and secondly, a nervous impulse starting at a sense organ must be shot up the sensory nerve, across the connector fiber, and down the full length of the motor pathway to contract the muscle at its end before the first rudiments of mental activity can be said to be evident. And all this establishment of reflex action, this tuning up of the nervous system for the communicating of impulses and the transformation of energy, has to be *learned*. Each cell of the nervous system has to be stimulated again and again before it finally passes on the impulse to its neighbor cell with celerity and precision. Those

persons in whom such a tuning-up process is either blocked or hindered from advancing at its normal rate we call either idiots, or imbeciles, or feeble-minded, or mental defectives. Those in whom it is ultra-rapid are geniuses.

Let us now consider how the newly born infant acquires some of its earliest habits and abilities, and first of all let us see how he learns to breathe.

HOW WE LEARN TO BREATHE

Breathing seems to us such a natural, inevitable, and instinctive activity that we are almost ready to protest that there was ever a time when we did not know how to do it. In spite of its present automatic and continuous character, breathing had a beginning; the nervous and muscular mechanisms which suck in and expel the air had once to be started going. How did this novel activity commence?

Of all the profound changes which birth involves, one of the most important is the change of temperature. The change from the mother's body to the air of the room is a drop of from 20 to 25 degrees. Such a difference in temperature would produce many subtle alterations in the adult, no matter how much he might have had to do with capricious climates and seasons. How much more must it affect the newly born child who lacks all such experiences! Besides, embryonic life is semiaquatic—the unborn lives in a fluid medium, without either light or air to affect his growth. These two changes, then—the great drop in temperature, and the novel experience of being suddenly surrounded with air—in a word, the shocks of being plunged into a different medium and being enveloped by new pressures—are the stimuli to breathing. That the change is

violent is betokened by the cry of the newly born—a cry none the less portentous because it is so welcome to those who assist and befriend his birth.

However, sometimes even the drop in temperature and the novel pressures of the air are insufficient to evoke this symbolic cry with which normal breathing originates. The officiating nurse or physician often holds the child up by the feet, and slaps it smartly on the buttocks, in order, by forcing the blood into the chest, to produce a temporary congestion there. This method is highly successful. The pressure of the accumulating blood is too much for the child to endure passively. To relieve it he spasmodically inhales once, twice, and again, and his breathing has begun. In this manner, by our responding to stimulation with muscular activity, and solely by means of the spinal cord pathways, every child born living learns to breathe. Ever thereafter, as long as life endures, the faithful *phrenic* nerve, whose fibers originate at the upper part of the spinal cord, lifts and lowers the diaphragm in ceaseless rhythm. And while breathing is chiefly a physiological phenomenon, and concerned much more with life than with mind, yet, since all emotional disturbances and many defects of speech are registered in the breathing, its importance for psychology is at once manifest.

HOW WE LEARN TO SWALLOW

We learn to swallow by a slightly more elaborate mechanism than is involved in breathing. The *esophagus* down which our food travels to the stomach is a series of elastic, muscular rings, called *sphincter* muscles. Indeed, the whole alimentary canal, from the lips to the anus, is a series of such ring muscles. Before birth none of these muscles

have ever contracted in coordination with one another. How, then, is this coordination secured?

The first feeding of the infant is by means of liquid food, the mother's milk. The first drops of this fluid are allowed to run into the infant's mouth, its head and body being inclined so as to allow gravity to play a part in the feeding process. When the first drop reaches the throat, it strikes (stimulates) the uppermost ring of the muscles of the esophagus. This ring contracts, and this contraction, together with the influence of gravity, forces the milk farther down the esophagus. But all along the esophagus the muscular rings are consecutively stimulated to contract by the presence of the falling fluid, and one after the other of these rings shuts and opens again. A wavelike succession of contractions is thus formed, the upper rings which first contracted being the first to expand and to be ready for the second drop of milk which is already there to be swallowed.

These muscular rings of the esophagus, however, do not act singly, but together. How is this coordination accomplished? A slightly new type of nervous activity is involved in this phase of our learning to swallow. There are not only sensory and motor nerves for each ring separately, but there are also sensory and motor pathways leading from ring to ring. And the spinal mechanism is so perfected at birth that the stimulation and contraction of one of the upper rings hinders the simultaneous contraction of the rings immediately below it. However, so nice is the nervous arrangement, and so precise do the functions of synapse and neurone become with practice, that the presence of food in the upper part of the esophagus automatically starts a wave of con-

traction down the whole tube. This is what happens when we swallow without any food being present. Were this not the case, we should never become able to eat and swallow while lying down or while standing on our heads. For in the adult swallowing is independent of the posture of the body. Such an automatic succession of contractions, which occurs in many other performances besides swallowing, is called the *chain reflex*. We shall have much to do with it later, as it concerns all habit formations, and the continuance of all our trains of thought as well. When this mechanism in the alimentary canal is disordered, so that the contraction wave is reversed, we have vomiting, nausea, and other distressing results.

HOW WE LEARN TO FIXATE

Another of the first things we learn to do is to fixate objects with our eyes. This special ability is not native, but acquired, and the process by which it is finally achieved is both curious and fascinating. At birth the eye of the infant is not yet fully developed. The fovea, or region on the retina directly back of the pupil, which is the spot of clearest vision in adults, is in the newly born unable to see anything at all. The rest of the infant's eye is, moreover, at this time unable to stand any intense light, and, in fact, registers pain when stimulated to any great degree. Only one part of the eye is able to bear light stimulation without pain, and that part is, strange to say, the fovea itself, which, being as yet undeveloped, has neither the power to see light nor yet to feel any discomfort from it.

A light streams diagonally into the baby's eye and stimulates it, producing thereby discomfort. The baby at once turns his head or his eyes, or both,

often with manifest signs of discomfort, this way and that, seeking to get rid of the light, until, by chance, the light is brought to stream directly on the fovea, whereupon he ceases his squirming and apparently gazes directly and placidly at it. But he does not therefore see it as we see it. He has merely succeeded in getting the light beam to bear upon the sightless part of his eye, that is, to cease to annoy him. Again and again this same performance takes place, day after day, and sometimes hour after hour, so that gradually he learns to turn his head directly to face the light the moment it strikes his eye from any step. Step by step, of course, his fovea has been developing a sensitive, seeing surface, and so, by the time sight is strengthened, he is able to make his eye bear directly upon the stimulus to vision. It is thus by avoiding the light in the first place that we later succeed in employing the eye to the best advantage. The adult turns his gaze not only fully upon whatever he wishes to read and examine, but often upon the source of every sound, smell, and movement which attracts him. This turning of the eye upon the stimulus, moreover, is what is ordinarily meant by the word attention.

THE GRASPING REFLEX: ITS GENESIS AND INTELLECTUAL SIGNIFICANCE

One of the most useful, persistent, and earliest acquired tendencies we possess is the *grasping reflex.* It consists of a propensity on the part of an infant to close its hand about any suitable object pressed against its palm, and to cling to that object tenaciously for ten or fifteen seconds even if it is lifted so high that the infant is suspended in the air. Whether this instinctive action is a relic of the tree life of our

simian ancestry is a question too difficult to be decided here. The point for us is that it is a purely spinal reflex, and does not involve the brain at all; "in one baby born without a cerebrum the reflex was practically perfect up to the day of its death at 18 days." Let us see how such a tendency begins and matures in the human being.

There are three causes which contribute to the strength of the infant's grasp. In the first place, *flexion* (by which we mean in general all such actions as drawing in the legs and arms close to the body) *is always more powerful and complete than extension* (or stretching the limbs, fingers, or toes away from the body). There are more and stronger muscles in the body for the purpose of flexion than for any other purpose. The calf muscle and the biceps are typical examples of this flexion mechanism. Moreover, the adult can exert much more force by closing his hand than he can by opening it. Grasping or flexion, then, is naturally one of the strongest actions of which we are capable.

In the second place, every muscle in the body upon contracting stimulates tiny sense-organs within it, which are connected by a sensory or receptor nerve with the central nervous system. This stimulation caused by the muscle's own contraction is transmitted to the spinal cord where it of course seeks an outlet. What outlet is provided for it? The outlet of the motor pathway already carrying the impulse which originally caused the muscle to contract is open, and it is into this channel that the new stimulation (that from the sense-organs within the muscle itself) is directed. The astonishing result is that the muscle by this means automatically reinforces its own contraction! This tremendously strik-

ing and novel phenomenon is called the *circular reflex.* When, then, the infant's hand grasps the bar to hold it, his own gripping accentuates the tenacity with which the bar is held.

Even so, however, we have not yet told how this grasping reflex originated, or why it developed in preference to any other instinctive action which the child might have manifested. Nevertheless, the cue to this mystery is not hard to find. For the hand of the embryo assumes, as it develops, a flexed form—the fingers are curved on themselves so that the finger tips nearly touch the palm. Not till the baby is born do the hands ever stretch out or flatten. The momentum of the posture gained in embryonic life is never thereafter lost. This is why we always hold our hands in a more or less arcuate position, as well, indeed, as why we cannot hold the fingers stretched out stiffly for more than a few moments at the most unless we give our undivided attention to it.

Now such a flexed posture of the hand brings with it certain all-important consequences. For the finger tips, it must be remembered, are sensitive surfaces, and the palm is likewise full of sense organs to which sensory nerves have already migrated from the spinal cord. Likewise the muscles of the fingers and palm have been supplied with motor nerves ever since these muscles were myotomes. So that if some random movement or jar which disturbs the embryo causes the finger tips to touch the palm of the hand, a stimulation will be given which will be carried by the sensory nerve up to the cord, by the conductor fibers across the cord, and by the motor fibers down from the cord again to the muscles of the palm and fingers, causing flexion or clenching of the hand. Such random stimulations are, indeed, numerous,

and every time they occur the embryo literally *practices* the grasping reflex. With practice the reflex becomes strengthened, so that by the time of birth the infant has developed a remarkably strong tendency to hold fast to anything that is placed between his palm and finger tips. Such a reflex also develops the sense of touch in the child, for just as motor response is essential to sensation and feeling, so are sensation and feeling necessary results of motor response.

We have, then, three causes of the strength and tenacity of the grasping reflex. The first is the great number and strength of the flexor muscles, the second is the circular reflex, and the third is the prenatal practicing by which the reflex is developed and perfected. Now let us look at some of the relationships between this reflex and the conscious and intelligent life of the adult individual.

To begin with, children born without a well-developed grasping reflex are both mentally and physically inferior to other children. And they are mentally inferior for a very definite reason, which is, that since it is by means of clutching and pulling things about that children learn the shapes and sizes of objects, it follows that the fewer things a child handles and manipulates, the less does he learn. The hand is *par excellence* the mechanism by which both young and old explore the environment and find out what it is made of. Where this mechanism is feeble or undeveloped, such self-education is seriously delayed and thwarted.

In the second place, our language is full of words which indicate that closing or clenching of the hand is a highly important activity in our dealings of man to man. Our word *pugnacity* is derived from the

Latin *pugna,* a fist, that is, a tightly closed fist, a fully perfected grasping reflex. Then there are such expressions as *grabbing,* and *snatching,* and *laying violent hands upon* somebody, which all refer to this same fundamental human activity. *Rapacity* is in all its modifications derived from grasping. We likewise refer to this same reflex activity when we speak of the *grasping* miser, the beggar with the *itching palm,* or the *close-fisted* landlord.

Furthermore, a great variety of expressions which describe physical possession or refer to the act of retaining what we have earned or stolen have their roots in the grasping reflex. To illustrate this we may mention all such words and phrases as *grapple* and *grab, keep hold of* and *fasten upon,* and *get into our hands.* The legal term *mortmain* (dead hand) refers to property so tenaciously held as to be inseparable from its owner; the *bird in hand* that is worth two in the bush signifies firm clutching and safe possession; while the common expression "he lost his grip" likewise reflects the great importance of the grasping reflex in adult life and behavior.

Even here we are not yet at the end of our list of derivations. Many terms signifying authority, whether they mean management, government, despotism, or tyranny, are fundamentally the grasping reflex. Witness such expressions as "gain the upper hand," "pull the strings," "wield the scepter," "take the reins of government," "rule with an iron hand," and the like. One meaning of the word *"rights"* is also based on the same grasping mechanism, for "possession is nine-tenths of the law."

Many of our tools have more than a superficial resemblance to the shape and function of the hand and

fingers. Such are *tongs, forceps, pincers, nippers,* and *pliers.*

Even more than this, many purely intellectual operations are based on our manual powers. *Apprehension* is catching on, and *comprehension* is seizing for the purpose of estimating. Then we have such words as *emancipation, mandate, manipulate, manufacture, manuscript,* and *manifest;* and such expressions as "right hand of fellowship" and "intellectual grasp," each and all of which in some way or other have their genesis in the powers and activities of the hand. The grasping reflex is, indeed, one of the most fundamental, significant, and far-reaching activities which the human organism manifests.

So much for a brief account of some of the first things we learn to do. The origins of mind are indeed curious, and the process by which we learn to feel and to think subtle and manifold. But every skill we possess and every intellectual power we finally come to achieve has, nevertheless, its roots and sources in such simple response processes as those we have just described. It is only because so many thousands of these reflex responses are going on at once that mind in its entirety seems to us so highly complicated and so difficult at first to comprehend.

CHAPTER IV

THE RÔLE OF INSTINCT IN MENTAL LIFE

FEW words in the language are used as freely, broadly, and loosely as the words *instinct* and *instinctive.* We hear of "the lion's instinctive fear of fire," of "the instinct of the salmon to swim up the river to spawn," of "the opossum's instinct to play dead" when pursued by a stronger or swifter enemy, and similar expressions by the dozen. The birds *instinctively* fly south in the fall and north again in the spring, the mother rabbit *instinctively* pulls out her own fur to make a nest for her litter, and the ducks *instinctively* take to the water. But these two words are also commonly used to refer to other things than the physical actions of the lower animals —thought and reason are often included within their scope. "*I instinctively knew* that there was a burglar in the house," and "*Her woman's instinct told her* at once that she had turned up the right road" are common literary devices to show to how great an extent intelligence may be automatic. And indeed, all such words as *intuition, premonition, hunch,* and the like mean little more than instinct itself. So broad and useful a term as this must surely have an interesting psychological origin.

It has. The definition of the word instinct at once reveals how many of our actions and how much of our thinking is included within its scope. *By the*

word instinct we mean all the inherited tendencies and all the acquired powers which we employ without any conscious effort or without recognizing them as being inherited or acquired. We never do and never can frame or contrive an instinctive action; and we are never aware at the time that we are acting or thinking instinctively; it is only in retrospect and with the aid of analysis that the source of such behavior is revealed and understood.

Now all this means very much in the life of each and every person. It means that more than half, sometimes even as much as nine-tenths, of our mental life—our skill, intelligence, reasoning, and so on—proceeds more or less independently of conscious influences. The words *unconscious* and *subconscious* are used to describe such a condition of affairs. Briefly, the subconscious mind means the sum of the knowledge or skill which we once patiently acquired, but which we now only recognize vaguely as our *experience;* while the unconscious mind refers chiefly to racial and family inheritances which give the peculiar trend and bias that makes the experiences we have acquired particularly *ours.* Our mind may thus be regarded as having three levels or layers. These layers are not distinct, but blend into one another like the colors of the rainbow. The uppermost but least continuous layer is termed consciousness or awareness; below that is the subconscious level, and lowest of all is the level of the unconscious. The discontinuity of the upper or conscious level is illustrated by sleep, by "wool gathering," and by such occasions as those upon which we "forget ourselves" or "meant to do otherwise." From this, moreover, it is clear that a study of the instinctive life of man (by which we mean all subconscious and

unconscious tendencies and processes) is of the greatest importance in psychology.

"Man is a bundle of instincts," writes William James, and he further declares that instincts are simply the natural actions which anyone might expect as the result of man's many organs and his highly complicated nervous structure. "With the presence of a certain organ goes, one may say, almost always a native aptitude for its use." Further than this, James writes in his clear and fascinating style: "The actions we call instinctive all conform to the general reflex type; they are called forth by determinate sensory stimuli in contact with the animal's body, or at a distance in his environment. The cat runs after a mouse, runs or shows fight before the dog, avoids falling from walls or trees, shuns fire and water, etc., not because he has any notion either of life, or of death, or of self, or of preservation. He has probably attained to no one of these conceptions in such a way as to react definitely upon it. He acts in each case separately, and he simply cannot help it, being so framed that when this particular running thing called a mouse appears in his field of vision he *must* pursue; that when that particular barking and obstreperous thing called a dog appears there he *must* retire, if at a distance, and scratch if close by; that he *must* withdraw his feet from water and his face from flame, and so forth. His nervous system is to a great extent a preorganized bundle of such reactions—they are as fatal as sneezing, and as exactly correlated to their special excitants as it is to its own." To ask, then, why we have any instincts is to ask why we have legs to be moved, hands to be clasped, eyes to be shut, and so on throughout the whole catalogue of body parts.

For, given a mechanism of any sort, certain natural activities of that same mechanism are bound to follow.

Such, then, is the nature of instinct. Instinctive actions are those which are the most readily performed by the human organism—those which it performs, first, best, and most persistently throughout its career. Each and every stimulus, indeed, arouses more or less of an instinctive response in us the more readily it arouses us at all.

This being so, it would seem possible that all living beings have instincts. They do have them. For not only do dogs, horses, and cats, and the higher species of wild creatures manifest instinctive tendencies, but all the lowest, tiniest, and least conscious creatures as well. Plants have instincts, for they all have definite structures, such as roots, leaves, and flowers, all of which respond to stimulation in the same way as do the animals. Nay, every single living cell in our bodies may be said to manifest instinct in all that it does to grow and help sustain our life. And, indeed, it is from a study of the tiniest living creatures and from the behavior of the individual cells of our bodies that we have been able to discover what the simplest and most universal instincts are.

What are the fundamental instincts? They are the reactions or responses made by living things to those conditions in the environment upon which life depends. Among other things, life depends upon the food supply—upon the amount and quality of nourishment which is supplied to the living creature. The organism responds to plenty by eating and thriving, and to an excessive lack by weakening or dying. All food is chemical stuff, just as is air and

water, and so the response to the chemical conditions of the environment is called *chemotaxis.* Taxis is a Greek word meaning "turning toward or away from," and signifies adjustment, adaptation, or behavior. Obviously, chemotaxis is a fundamental instinct possessed by all living beings.

See, now, how far-reaching this instinct of chemotaxis is. All living creatures must eat if they are to survive, grow, and reproduce, and man is no exception to this general rule. Not only so, but man, as well as the bee and the squirrel, is wont to lay by his winter's food when the supply in summer is plentiful. In this action instinct and intelligence may be said to coincide, especially in the bee and the squirrel, for neither of them consults the calendar or knows in how many days it will be winter and the snow. Instinct, then, can and often does involve foresight. Whether we call such foresight conscious or not makes no difference in the life-preserving results of the action. But man goes much farther than the bee and the squirrel in his chemotaxis. For if we consider how many human activities are involved in the food-getting of the human race, such as plowing and sowing, seed-gathering and harvesting, warehousing and butchering, marketing and vending, the manufacturing of farm tools and the building of ships to carry food to the antipodes, it will be plain not only how fundamental chemotaxis is, but also how large a share of each of our lives (and of some of us all our effort) is dominated by this particular instinct. Witness also that since water and air are chemical necessaries of life, all labor to store, carry, and purify the drinking water, and to furnish adequate pure air to men in mines and tenements is chemotactic behavior. Further-

more, since all disease germs which enter us disturb the chemical stability of the blood, the process of becoming immune, and the struggles against death which we call diseases, are also examples of the instinct of chemotaxis. Indeed, *chemotaxis may be rightly called our instinct for self-preservation.*

Not only do all living creatures crave and seek for food, but they require a certain temperature in which to thrive and prosper. In so doing they manifest another elemental instinct which is called *thermotaxis,* or their adjustment or behavior with respect to warmth and cold. All chemical processes depend upon temperature, and so thermotaxis and chemotaxis go hand in hand. Winter with its decline in heat and its increase of snow and ice kills some living creatures outright, and causes a decline or retardation of vitality in many others. Winter tends to retard even some of man's activities, as is witnessed by his numb fingers and toes. The temperature in which life thrives best is called the optimal (or most favorable) temperature. The distribution of population over the earth's surface is an index of where the optimal temperatures are found, namely, in the temperate zones. Vegetation appears to require a slightly higher temperature than man for its most luxuriant growth, as is witnessed by conditions in the tropics. Nevertheless, the temperate zones seem to supply the optimal conditions of human life, for not only are the world's granaries located there, but the most upstanding and intelligent races live within that domain. The distribution of population is, therefore, based upon the instinct of thermotaxis.

Thermotaxis is also shown in many common ac-

tivities of man and the animals, conscious or otherwise. It is shown in our custom of going south for the winter and seeking the cool mountains in the summer vacation. Indeed, "The turtles are on the rocks and the millionaires on the verandas at Palm Beach for the very same reason." The hibernation of animals, Cæsar's army going into "winter quarters," the migrations of birds, "sun-worship," "fire-worship," pulling up the bedclothes as the night grows chilly, and even our inventions of steam-heating plants and electric fans are all fundamentally thermotactic behavior. Needless to say, the leaves, flowers, and fruits of all vegetation are one and all responses which the plants make to the temperature of their environment.

Light, as well as food, water, air, and temperature, elicits from us a third kind of instinctive action, called *heliotaxis.* Helios is a Greek word for sun, and the sun is the principal stimulus for this kind of response. Plants manifest this instinct rather more universally than do animals, for certain chemical processes in plants are absolutely dependent upon the presence of light, whereas some animals are blind and only smell their way about. But light helps us find our bearings in the world, discover our food, avoid pitfalls and accidents, and aids us in a thousand other ways, and so becomes a very important factor in the sustaining and developing of life and mind. Obviously, from what has gone before, our artificial lighting system, our mirrors and window blinds, our luminous paint and our flashlights are all skillful contrivances in the interest of heliotaxis. Even the expression "to get light on our problems" is derived from this instinct. On the other hand, since darkness has its value both for plant and ani-

mal life, we may be said to seek it, too, as periodically and instinctively as we seek the light.

A fourth fundamental instinct concerns the adjustment of all living things to the pressures of the air, the earth, the water, the wind, and all physical forces whatever with which they have to deal. This instinct is called *barotaxis.* The word "baro" is familiar to us in the barometer and the barograph, two instruments used in recording and predicting the weather. By air pressure we are held together as compact physical bodies. Were this pressure to vanish, we should crumble to pieces or burst as do the deep-sea fishes upon being brought up to the surface. Earth pressure also keeps us upright. We cannot stand or navigate or keep our balance in bogs or quicksands. Even more than this, however, all growth and nutrition are dependent upon the pressure relations established and maintained between the parts and organs of our bodies. Circulation, respiration, digestion, bone growth, and the like all depend upon pressures and velocities of various degrees and rates, so that our vital well-being is almost as much dependent upon pressure as it is upon food, light, and air. It is our barotactic instinct which makes us react to the dense air of a stuffy room by a feeling of suffocation; which makes us push and jostle when a dense crowd endangers our safety; and it is also barotaxis which actuates us when we loosen our clothes and shoes to give us relaxation and rest.

And now we come to two instincts which are best mentioned together. Food, air, warmth, and cold not only stimulate us in general, but they also usually stimulate us to go toward them or away from them. This directive tendency, this pull or push,

enticement or revulsion which we feel as the result of the presence of the stimulus is truly instinctive, even though in many cases it has become the result of training or experience. We shall call these opposite ways of responding to stimulation *outgoing* and *withdrawing* reactions respectively. Their importance for psychology can at once be seen to be enormous.

For *outgoing* means the use of one set of muscles, in general the *extensors,* and *withdrawing* means the use of the opposite set, the *flexors.* The outgoing or extensor mechanism is concerned with such acts as walking, reaching out for, peering and prying—in a word, all such actions as acquaint us with larger sections of our environment; while the withdrawing or flexor mechanism is on the whole used in such actions as crouching, closing the eyes, lowering the head and chin, shrinking—in a word, with narrowing our range of action to the smallest possible compass. He, then, whose dominant reactions are outgoing is the adventurer, the discoverer, the man born to rule and to command, the open, frank, and generous individual; while the person whose dominant reactions are withdrawing is the stay-at-home, the provincial, the follower, the timid, the covert, the nonresistant and the stingy type of individual. And, as we have all observed, certain of our acquaintance are easily described as belonging to one or the other of these classes. Dominant traits of character are thus often instinctive with many people.

These two reactions, however, do not differ only in their outward appearances. Indeed, what is going on within the skin is, if anything, more important than what one observes in the movements and

postures of the body as a whole. For the outgoing reaction releases great quantities of energy ready to be discharged, while the withdrawing reaction bottles it up. Now the energies of the body are all so delicately adjusted one to the other that if they are not released or transformed at the moment they are ready to be, serious results often follow. Our expression "sour disposition" is almost scientifically correct, for too many withdrawing tendencies create a chemical condition very much akin to that of sour milk. On the other hand, we have the expression "sunny disposition," which quite adequately describes the person whose general tendencies are outgoing reactions. For the sunny disposition really means that energy is being released and transformed in the same way as the sun's warmth is sent out to effect beneficial and wholesome changes in the world.

Such, then, are the fundamental instincts of all living beings, including man. They are, however, almost never seen in their simplicity, especially the last two we have mentioned. They get modified by experience, refined by habit, and altered by practice and association. Among these modifications we may mention the following, all of which will be taken up later in the chapters on emotion and sentiment:

1. *Flight* from a dangerous object, attended by the fear of it. (A withdrawing reaction.)

2. *Repulsion,* accompanied by disgust. (Withdrawing reaction.)

3. *Curiosity,* accompanied by wonder. (Outgoing reaction.)

4. *Self-abasement* or *subjection,* accompanied by dejection. (Withdrawing reaction.)

5. *Self-assertion* or *self-display*, accompanied by elation. (Outgoing reaction.)

6. *Pugnacity*, accompanied by anger. (Outgoing reaction.)

7. The *reproductive* and *parental* instincts, with their attendant emotions. (Outgoing reactions.)

8. *Sympathy*. (Either outgoing or withdrawing.)

9. *Suggestibility*. (Usually outgoing.)

10. *Imitation*. (Usually an outgoing reaction.)

Some psychologists extend this list indefinitely, and speak of racial, family, and individual tendencies of all sorts as equally fundamental instincts. Perhaps they are correct, but it seems best here to reserve those well-defined traits which come only with experience for the list of habits and associations. The fundamentally instinctive actions are, as we understand them, only those which we manifest before training and experience have modified us, and which we also share with all living creatures.

CHAPTER V

THE MOTORS OF THE BODY

SO far we have been seeing how the various single elements of the mental machinery are constructed, and we have also been shown a little how they separately work; it is now time that we assemble these parts and view them in cooperation with one another. In Chapter II we examined the smallest parts of the machinery of the mind—the reflexes—and showed how the whole nervous system is a vast complexity of terminals, batteries, and switchboards; in Chapter III it was made clear how some of the mental apparatus gets tuned up to perform its proper functions; and in Chapter IV we have just seen with what sort of directive energies the human body is charged, and through what channels this energy is drained off: in this present chapter we are to show the larger dynamos and motors of body and mind working at their full speed. This collection of powerful engines has been called the *kinetic system.*

It is to Dr. George W. Crile that we owe our knowledge of this system of dynamos and motors. Following Sherrington's maxim, "Environment drives the brain, and the brain drives the various organs of the body," Dr. Crile has developed a theory to explain just how this driving of the body is accomplished. Let Crile speak for himself: "My thesis is that environment has been the actual creator of

man; that the old division between body, soul, and spirit is nonexistent; that man is a unified mechanism responding in every part to the stimuli given it from without by the environment of the present, and from within by the environment of the past, the record of which is stored in part in cells throughout the mechanism, but especially in its central battery —the brain.

"The essential function of the nervous system was primarily to secure some form of motor activity, first as a means of securing food, and later as a means of escaping from enemies and to promote procreation. Activities for the preservation of the individual and of the species were and are the only purposes for which the body energy is expended. The central nervous system has accordingly been developed for the purpose of securing such motor activities as will best adapt the individuals of a species for their self-preservative conflict with the environment.

"It is easy to appreciate that the simplest expressions of nerve response—the reflexes—are motor in character, but it is difficult to understand how such intangible reactions as love, hate, poetic fancy, or moral inhibition can be also the result of the adaptation to environment of a distinctively motor mechanism. We expect, however, to prove that so-called 'psychic' states as well as the reflexes are products of adaptation, that they occur automatically in response to adequate stimuli in the environment; that, like the reflexes, they are expressions of motor activity, which, although intangible and unseen, in turn incite to activity the units of the motor mechanism of the body; and, finally, that any 'psychic' condition results in a definite depletion of the potential energy

in the brain cells which is proportionate to the muscular exertion of which it is representative."

Hints of this novel and fascinating theory have been already given in our previous chapters. The various forms of taxis are one and all motor activities, and we have already seen how important such things as chemotaxis are for the individual as well as for the race. Likewise, the social and intellectual importance of the grasping reflex indicates to what an extent the vast complexity of the mind may be explained by relatively simple formulas. Crile continues:

"This work began with an attempt to solve the problem of surgical shock, from which it progressed further into the field of disease phenomena, and, finally, into the domain of so-called 'normal' processes. We found also that, as the result of shock or exhaustion from any cause, certain changes occur uniformly in certain organs—notably the *brain*, the *liver*, and the *adrenals*, and we discovered that the phenomena of shock could be eliminated by the prevention of preoperative fear and by 'blocking' the nerve paths from the field of operation to the brain by local anæsthesia in addition to general anæsthesia. These facts having been established experimentally and clinically, a *kinetic theory of shock* was formulated.

"Having demonstrated the apparent truth of the *kinetic theory* for traumatic (operative) and psychic shock, we undertook further researches to determine whether this theory explained also the exhaustion produced by infections, by drug stimulants—such as strychnin, by toxins, by foreign proteins, by insomnia, by exertion, etc. To this end we examined all the organs and tissues of animals

exhausted by the bacteria and toxins of infections, by foreign products, by drug stimulants, by adrenalin, by thyroid extract, by many other activating substances, and by insomnia. The results of this study showed that, as in shock, *changes were produced only in the brain, the adrenals, and the liver, whatever the cause of the exhaustion.*"

It is to these organs, together with the thyroid glands and the muscles of the body, to which Crile has given the name "The Kinetic System." This system does not directly circulate the blood, nor does it exchange oxygen and carbon dioxide, nor does it perform the work of digestion, of elimination, or of reproduction. But it is the principal mechanism by which the vast transformation of potential into kinetic energy is accomplished, by which action is effected, habit acquired, experience gained, and by which countless other special and general mental activities are performed. The various functions of the organs of the kinetic system are as follows:

"The *brain* is the initiator of response, being activated by the environment within or without the body; acting like a storage battery, it contributes the initial spark and impulse which drives the mechanism. The *adrenals* act as oxydizers, making possible the transformation of energy and the neutralization of the resulting acid products. The *liver* is the chief fabricator and storehouse of the carbohydrate fuel by which muscular action and heat are produced. The liver also plays a rôle in the neutralization of the acid products of the transformation of energy. The *muscles* are the engine or motor in which is consummated the final step in the transformation of energy into heat or motion. The *thyroid* by supplying a secretion which facilitates

the passage of hydrogen ions would seem to be the organ of speed control, governing the rate at which the transformation of energy is effected."

See, now, how much more of the body than just the brain is concerned with mental activity. For if the word "mind" means all such things as learning, acquiring experience, forming habits, responding to stimulation, transmitting impulses, and transforming energy, far more than the nervous system or the cerebrum is at every instant of time involved. In other words, we do not think, feel, or act except with the cooperation of all the important organs and parts of the body except the bones. Furthermore, if it is this *kinetic* system which is required for all mental processes, we may also declare that ambition and courage, force of will and strength of purpose, all have their origin and support in these motors of the body. Not, of course, in the mere anatomy, shape, color, weight, and the like of any one of them or of any group of them, but rather in the cooperation and togetherness which they ceaselessly and stalwartly manifest. We may also claim that the first things we learn to do, the integrity of reflex response, and the activities of chemotaxis, barotaxis, thermotaxis, and heliotaxis are all carried out by this kinetic mechanism, from which it follows that the health of the body as well as the vigor of mind are dependent upon the degree to which the kinetic system is able to maintain its powers and energies intact against the forces of disease which constantly threaten it. Mind, then, far from being merely a reservoir of fleeting ideas, is the greatest "going concern" of the whole body.

CHAPTER VI

SENSATION: ITS NATURE AND VARIETIES

SENSATIONS are particularly marked off from other mental activities in that they are referred to some particular part of the body. For while emotions, memories, and imaginations are seldom felt to occur at any particular spot or in any single limb or organ, sensations are usually very precisely localized. Nausea, toothache, cramp, burns, and smells, for example, are one and all referred to some definite locality on or within the skin.

One reason for this precise localization of sensation is that there are distinctly different sense organs in the body, each one of which is attuned to receive its own kind of stimulation and none other. The receptor organs in the retina of the eye are attuned only to the stimulus of light; the receptor organs in the ear are vibrated only by the stimulus of sound; the nose alone responds to odor, and the tongue alone to taste. This means that each sense organ is specifically receptive to only one form of nature's many energies.

Another reason why sensations are distinctly localized is that whenever a receptor organ is stimulated, reflex nervous action is produced which ends in the response of a particular set of muscles and glands. Not only are the sense organs each specifically receptive, but the subsequent nervous action

brings about a specific motor response. The specific stimulus of dust in the eye brings about the specific response of winking and tears; the specific stimulus of a needle prick on the skin starts the specific response of vigorous defensive movements. Similarly, red light thrown into the eye immediately raises the blood pressure, while green light again reduces it. Indeed, we may publish it as a law of psychology that the mental activity known as sensation is absolutely dependent upon such specific muscular or glandular response. The impulses which are blocked at the synapses are as good as lost—there is no resulting sensation.

It may be helpful for us to enumerate and classify the various sensations. And be it marked well by the reader, that *the number of senses is far greater than five.* Twenty-five is nearer the correct number, if separate organs and correspondingly different responses are of any significance. And these senses are, moreover, divided into three classes, called:

1. Visceral senses (or interoceptive, i. e., having their receptors within the vital organs themselves).

2. The muscular senses (proprioceptive, or having their receptors in the mechanisms of locomotion and balance).

3. Surface (or exteroceptive) senses, having their receptors either just below the skin surface, or in organs which are exposed to the air through the skin, such as the eye, ear, and nose.

The list of known senses is divided among these three groups as follows:

1. Visceral senses: hunger, thirst, nausea, cramps in the stomach, suffocation, flushing, heart panics, sexual sensations, obscure abdominal sensations oc-

curring in fright, anger, etc., and referred to by the ancients as "yearning of the bowels."

2. Muscular senses: The roomy feeling when a muscle is squeezed; tendinous strain, especially felt in the act of standing long on the toes; joint sensation, felt in pushing a heavy object; distension of body cavities, such as stomach, rectum, bladder, etc.; sensations of balance or of dizziness, falling, and the like.

3. Surface senses: touch (superficial and deep), warmth, cold, pain, hearing, vision, smell, and the combinations of skin senses known as tickle and itch.

The study of sensation, to which this and the following seven chapters are devoted, is highly important for the understanding of mental mechanisms. However, it must be understood that sensations rarely occur by themselves. Rather do they come in great confusion and abundance, and they are also habitually accompanied by associations, memories, imaginations, emotions, and other complicated mental processes. For example, we may say that we *taste* lemon pie, but, as a matter of fact, we are then not only tasting, but smelling and remembering as well, and, if we praise the hostess for the excellence of her pastry, sentiment and imagination may also enter into the situation. Rather, then, should we say that we have a sensation of sour, but perceive or understand that we are eating lemon pie. From this we see that the study of sensation is highly abstract, since it concerns only a particular element of mind. This, however, is the true scientific method—first to find the simplest mental factors, and then to see how they are united to produce that long chain of conscious and subconscious experiences which collectively we call the human mind.

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A TEST IN ORIENTATION. The subject is whirled about over a chart marked to indicate the various directions. He then endeavors to tell the direction in which he is facing.

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A TEST OF THE SENSE OF EQUILIBRIUM. It depends on sensations of the labyrinth or inner ear.

CHAPTER VII

HUNGER AND THIRST

THE visceral sensation known as *hunger* is caused by violent, spasmodic contractions of the walls of an empty stomach. It is a special manifestation of the instinct of chemotaxis, arising from want of food, and is characterized by a dull crowding located at the pit of the stomach. It is not merely the emptiness of the stomach which produces this sensation, but it is rather an empty stomach undergoing violent contractions. The stimulations brought on by a lack of food in the alimentary canal must produce these violent contractions before the sensation of hunger results.

Precise investigation has shown this statement to be true. The man who volunteered to be the subject of this experiment went for some hours without taking food, and then, when he began to feel the pangs of hunger, he carefully swallowed a hollow bag of thin rubber, to which was attached a rubber tube. When the bag had reached the stomach, it was then inflated by means of the rubber tube so as to fill the stomach more or less completely. As soon as the bag was filled with air the feeling of hunger was partly relieved, since the muscular contractions of the stomach were at that moment reduced in intensity. However, when some of the air was let out of the bag, the dull, crowding ache recurred, proving that the character and extent of the

contractions—that is, the muscular response—were necessary to produce the sensation. Of course this little joke could not be played on the stomach indefinitely, but the experiment showed that other things than food can at least temporarily mimic the effect of food. This fact has been illustrated in the case of hungry and starving explorers, and men lost in the wilderness or on the sea. Even indigestible moss, leaves, roots, and shoe leather will suffice, by filling the stomach, to allay hunger pangs for the time being. Tightening of the belt produces a similar effect, through crowding the organs of the body together so as to make the more extensive movements of the stomach impossible. The sensation of hunger is thus dependent upon motor response, and upon the release of the body's energies by means of a precise muscular mechanism at a certain rate and at a certain rhythm.

Thirst, like hunger, is a local sign of a more or less general bodily condition. As hunger signifies the lack of food, so thirst betokens the lack of water in the body. Water is a necessary condition for the existence and maintenance of life in all its forms. Although water does not by itself furnish any supply of energy to the body, "it is an essential constituent of all living matter, and takes part in all the changes which determine the transformation of matter and energy in the organism." The specific stimulus for thirst is probably a drying of the mucous membranes in the pharynx. The precise reaction or response is not exactly known, but it is very likely an inert and inflexible condition of the muscular walls of the pharynx. Swallowing becomes difficult, and even sharply painful; and as the thirst increases, the tongue, soft palate, and cheeks

become involved in this inert and inflexible condition. The throat and tongue may also become badly swollen. Thirst unrelieved, such as shipwrecked sailors have suffered, is, of course, fatal. Before death it may produce such chemical change and deterioration in the whole system as to bring on fainting, coma, or a maniacal condition. This sensation is, like hunger, a form of chemotaxis.

These two sensations have been mentioned first, not because they are the best known or the most developed, for they are not, but rather for the reason that they furnish an unusually good illustration of the basic connection between all sensations and the kinetic system. For hunger and thirst drive us quickly and far in search of food and water. Beginning with local discomforts, they soon provoke a general restlessness. This general restlessness and craving at once start the larger mechanisms of locomotion into activity; and these mechanisms are, of course, the voluntary muscles of the kinetic system. Hunger and thirst are thus truly *driving forces.* They prod us to go about and to seek for food and water with which to restore our chemical condition to normal.

Now, I think, we can understand the meaning of sensation as given by Dr. Max Verworn in his "General Physiology." "Sensation," as he defines it, "is any change in the vital conditions." In other words, all sensory stimuli whatever produce an alteration in our whole being. For, though they apparently produce only a local effect, they are really causing profound changes throughout our whole body. This was also hinted a few pages back, where it was said that the color red *raises*, while the color green *lowers,* the blood pressure. It is the same way

with all sensory stimuli whatsoever. In every case of sensation either the rate, the composition, or the pressure of the blood is altered, the activity of some gland is excited or depressed, or the whole kinetic system is roused to activity which furthers or sustains the life process. In brief, then, sensations are one and all either warnings of a state of vital ill-being (as in the case of hunger, thirst, nausea, and cramp), or else they are signs that in our body and brain changes are taking place which will affect our entire physical and mental make-up. *Every stimulus thus educates us and enters into our experience,* and our sensations are the signs that this learning process is perpetually going on.

CHAPTER VIII

TASTE AND SMELL

THE senses of taste and smell are much more important for psychology than are hunger and thirst, since they are more highly developed, have more varied qualities, and enter into and modify our conscious life to a greater extent than is the case with hunger and thirst. Taste and smell have been carefully trained to test our food before it is swallowed. Is this meat good? Is that water fit to drink? Let the nose and the tongue decide. Standing guard over what we eat and drink has thus obliged the senses of taste and smell to discriminate, often very carefully, between edible and poisonous, digestible and nauseating food. Figuratively speaking, the stomach says: "Give me something, anything, to allay these pangs of hunger." The tongue and nose reply: "Patience, my good stomach, wait until we find something profitable to fill you with." The intimate relation between these various senses is also shown by the fact that the smell of some foods not only causes our mouths to water, but also our stomachs to begin to secrete gastric juice for the purpose of digesting what we smell. Vice versa, at the smell and taste of nauseating substances, the whole alimentary canal seems to be on the point of violent and open revolt. Taste and smell are, indeed, like hunger and thirst, forms of the instinct of chemotaxis, and are frequently called the chemical senses.

The sensory receptors for taste are located on the tongue, but they are not visible to the naked eye. If you stretch out your tongue before a mirror, you will see that its surface is covered with little pink eminences or papillæ. The microscope reveals that each hill or papilla is an elaborate structure, and that on the sides of the hill are located budlike organs, from the center of which a tuft of fine hairs protrudes. Papillæ are found, not only on the tongue, but also on the hard and soft palate, the tonsils, the inner surface of the cheeks, the epiglottis, and even in the middle ear. The receptor organs are stimulated only by substances that will dissolve in the saliva. For this reason powdered quinine is almost tasteless, and pure powdered charcoal is entirely so. There is a great difference to be noticed in the time elapsing between the application of various substances to the tongue and the moment they arouse a taste sensation. This period of time is called the *latent period.* It is on account of the latent period that the taste of some substances may not be fully appreciated until after they are swallowed. Perhaps also for this reason we sometimes say: "It tastes good on the way down."

Although we say that every article of food tastes differently, there are recognized in psychology only four distinct qualities of taste: sweet, salt, bitter, and sour. Some writers add two more: an alkaline and a metallic taste. All the rest that we call taste is really smell. The taste of salt is the only one that can be aroused with equal facility from all parts of the tongue. Sweet and sour are provoked best at the tip and sides of the tongue, and bitter is aroused best from the papillæ at the back of the tongue. Some papillæ also respond

best to one, and some to another substance. The middle of the tongue, except in very young children, is absolutely insensitive to taste. "The delicacy of the sense of taste depends on the temperature of the solution employed, and is increased also by rubbing the substance against the tongue." The amount of substance required to produce a taste sensation has been accurately measured. It has been shown that a smaller quantity of bitter or sour is required than either of salt or sweet. The amount of a stimulus necessary to arouse a sensation is called the *threshold of sensation*. This word "threshold," with which we shall have much to do in the next following chapters, suggests that a certain resistance must be overcome before the stimulus can enter consciousness. Indeed, every sense organ has its own specific inertia which has to be surmounted before even an impulse can be started toward the brain and spinal cord. Likewise, every synapse between nerve fibers offers resistance which has to be broken down before a nervous impulse can pass beyond it.

The fact that it requires a certain amount of a stimulus to arouse the sensation of taste accounts for the quantity of sugar we demand for our coffee and lemonade. Too little seems almost worse than none at all, because we have educated our tongue to a high threshold which must be passed before the coffee and the lemonade become recognized as agreeable to our experience, that is, to have the right taste. The partial obliteration of one taste by another is called *compensation*. The best examples of compensation are found between sour and salt, the worst between sweet and sour. It is for this reason that many people prefer to sprinkle their grapefruit

and tomatoes with salt instead of sugar. Very weak stimulations of tastes can practically annul each other. A dilute solution of sugar becomes almost tasteless with the addition of a few grains of common salt.

The action of some drugs deadens or annihilates certain tastes. For instance, cocaine, if painted on the tongue, abolishes the burning effect of acids, so that only the sour taste results. Cocaine will also reduce our sensitivity to bitter and sweet, and to sour as well, while the salt remains unaffected. Gymnenic acid abolishes our sense of sweet.

Contrast effects in taste are very common and very easy to demonstrate. After drinking highly sweetened coffee, coffee with only half the amount of sugar tastes distinctly bitter. Lemonade after peppermint drops tastes frightfully sour. After solutions of either salt or sour, solutions of sugar previously too weak to produce any taste sensation at all are now recognized as sweet.

We adapt to some tastes only by a process of slow learning. Olives, tobacco, and, with some people, caviar have to be taken many times in order to become agreeable. Such tastes are called acquired. This process of acquisition proceeds somewhat as follows: The naturally withdrawing or rejecting reaction must be checked, and an outgoing reaction established in its place. This often requires a long time, but the process is always hastened by the presence of other persons who, by manifesting evident pleasure toward the thing tasted, inspire the novice with the ambition to persevere. This stimulus of the other people serves to start a reaction which needs the same nerve pathways as have been employed by the withdrawing reaction. Gradually the

pathways unlearn their former connections, usually through sheer force of the new stimulus, until the taste finally becomes acquired. Such a nervous track is, of course, a *final common path*, which two opposed stimuli cannot fully use at the same time. The final common path is made up of many, perhaps even thousands, of nerve fibers. When the learning begins, only one or two fibers may carry the new impulse, while at the completion of the learning all the fibers are carrying the same sort of impulse. This change can even be felt. The seventh or eighth olive is much more readily swallowed than was the first or second. And the ease and success—one might almost say the whole-heartedness—with which the fortieth olive is consumed indicates that all the fibers in that particular final common path are producing the same kind of motor response.

Tastes sometimes blend together so as to produce a mixture which gives a different sensation from that of either of the components. This is called *fusion*. To some people lemonade is not merely sour plus sweet—it is a distinctly new sensation. Salads, sauces, and, in fact, many of our common dishes of the table are fusions of tastes. Of course, smell, temperature, and other sensations enter into these fusions so largely that the actual *taste* plays only a small part in the experience. What taste there is, however, can always be detected by holding the nose. It is because the nose is out of action during head colds that our taste and appetite are often so unsatisfactory at those times.

Now let us see what sort of a mechanism is required for the sensation of taste. We know that the taste buds are sensitive organs which receive the stimuli, and we also know that there are sensory

nerves running from these taste buds into the central nervous system. But is that all? Do we taste sweet, sour, bitter, and salt simply because a nervous impulse is sent into the spinal cord? By no means. For it has already been made plain that, unless the impulse which is started along a sensory nerve toward the central nervous system is again shot back by a motor nerve to the muscles and glands of the body, no sensation whatever can be experienced. That impulse which is blocked at a synapse is like a letter which is lost in the mails. Neither one fulfills it purpose. What responses, then, are produced by the four kinds of taste stimuli?

The proof that such responses take place is so clear, and so readily obtainable, both from ourselves and others, that it seems almost needless to dwell upon it. If you will take small quantities of sugar, salt, quinine, and lemon pulp, and place them upon the tongue one at a time (being sure to cleanse the tongue thoroughly between times), and if you will watch all the observable results of such stimulation, you will see such obvious differences as the following:

1. The grimace which spreads over the whole face, upon taking quinine, and which betokens a violent withdrawing reaction, is totally absent in the case of the sugar. Besides, the salt and the lemon pulp, while perhaps more readily swallowed than the quinine, will each produce facial expressions plainly different from those which either the sugar or the quinine provoked.

2. The amount of saliva which each of these stimuli calls forth, and the rate of the flow of this saliva, can be felt or even seen to vary in every case. Here, then, we have clues to two different sorts of responses—muscular and glandular. Had the facial

muscles and the salivary glands responded in exactly the same way to each of the four substances put upon the tongue, they would have all tasted precisely alike. It was because of the variety of responses provoked by the stimuli that different tastes were experienced.

Fusions, compensations, rivalries, and adaptations in taste are, then, due solely to the fact that the simple, natural muscular and glandular responses are modified and combined in so many different ways. Bitter-sweet chocolates, sweetened coffee, salted tomatoes, and a host of other familiar foods and drinks taste as they do simply because they evoke such combinations of responses. Strongly imaginative persons can often get the sensation of taste before the tongue is touched by the stimulus. They often show it when they are about to take a dose of epsom salts: their faces grimace with the response to bitter even before they have opened their mouths. And, be it well noted, such people actually *do* get the taste of the stuff by means of such an anticipatory response. Vice versa, we have all felt our mouths water (glandular response) at the sight of some dainty morsel about to be offered us. To be sure, only at rare intervals are all these responses to tastes observable, for it has become a custom with men to hold their faces severely in check, to smother their grimaces at bitter and sour tastes, and to let the lower animals do all the licking of chops. But these tendencies are always latent, and these various responses are so essential to producing vivid taste sensations that, even when we seem to be preventing all outward manifestations, the responses are simply "going on low gear" within the muscles of the tongue and face.

How, now, are such muscular and glandular re-

sponses carried out? Branches from three of the twelve cranial nerves send sensory or receptor fibers to the papillæ of the tongue: (1) the 5th or trigeminal nerve, (2) the 7th or facial nerve, and (3) the 9th or glossopharyngeal nerve. All these nerves have adjacent switchboards in the thick upper part of the spinal cord (the medulla) near the fourth ventricle of the brain. From this same region of the medulla also proceed various motor branches of the cranial nerves: (1) a branch from the 7th nerve, (2) a branch from the 9th nerve, and (3) branches from the 12th cranial nerve, the hypoglossal, whose function is to move the tongue about in the mouth. All these motor branches produce the characteristic facial expressions that are essential to taste sensations. And these various sensory and motor pathways are required not only for the transmission of impulses to and from the brain, but also for those transformations of energy without which the taste qualities could not be appreciated. For if any one of these many pathways, either sensory or motor, is cut or destroyed, our faculty of taste is greatly interfered with. Beside all these nervous pathways to the muscles of facial expression and swallowing there are motor fibers running to the salivary glands regulating the quantity and rate of the flow of their secretions. It is even possible that the tear glands are connected with the response mechanism of taste, for many acrid and bitter substances evoke their characteristic flow of tears. Needless to say, the esophagus and the stomach also frequently join in the responses to taste, since they prepare either to accept or reject that which the tongue is trying. And so we see that the sense of taste, far from involving only the tongue, more often than not involves a hun-

dred other important organs and glands of the body besides.

THE SENSE OF SMELL.

The sense of smell, like the sense of taste, stands guard over what we put into our mouths to be chewed and swallowed. As hinted before, much that we call "taste" is really flavor or odor derived from the sense of smell.

The causes of this confusion of taste and smell are not difficult to find. One is that we are so much more conscious of the tongue, by which tastes are both received and responded to, than we are of the nose. Whether that which we eat smells agreeably or otherwise, it is largely the tongue by which our acceptance or rejection of it is manifested. Another reason is that many substances do not get smelled by the nose until they have been taken into the mouth and chewed. For there are two passages into the nasal cavity, one at the nostrils, the other behind and above the soft palate, into either of which vapors can rise to affect the organs of smell. Consequently, substances sending vapors into the nasal cavity by these inner nostrils are likely to be felt as taste simply because they produce no sensation until after they have been taken charge of by the tongue. And a third reason for our mistaking smells for taste is that civilized man has ceased to cultivate his sense of smell except, perhaps, in connection with flower gardens and perfumery.

This, however, does not mean that our sense of smell has degenerated beyond recovery. The extreme sensitivity which tea tasters cultivate is adequate disproof of this. On the other hand, the sense of smell has largely fallen into disuse. "The reason is that smell is essentially a ground sense, as you may

convince yourself any summer day that you lie out on the grass, or at any time that you are willing to spend a few minutes on the dining-room floor; birds in general have a very obtuse sense of smell, and many of them perhaps lack sensations of smell altogether. When, then, mankind assumed the upright position, and the nostrils were lifted several feet above the surface of the ground, the sense was removed from its normal environment, and fell into disuse; sight and hearing took its place."

We call the nose the organ of smell, but this visible adornment of our faces serves only to draw in the odorous vapors. The real sense organs of smell are located high up in the nasal cavity entirely out of sight. Two small patches of brownish mucous membrane, each about as big as the little finger nail, and situated on the under side of the bony floor of the brain, contain the receptors for odor. The nasal passages, right and left, are separated by a bony partition, so that when one nostril is stopped by a plug of cotton or by a cold in the head, we may still smell with the other. These brown patches cannot be stimulated directly unless the subject lies down on his back, tilts his head forward, and allows odorous liquids to be poured very carefully into his nose; "but particles carried into the outer nostrils by the breath stream, or into the inner nostrils by the air stream thrown back in the act of swallowing, eddy upward to them and thus arouse sensation."

The real organs of smell are, then, not on the main line of the air currents that reach the throat from the nose. Nevertheless, this indirectness of stimulation has its decided advantages: (1) the cold air of winter is not allowed to damage the sensitive surfaces; (2) bacteria do not get deposited there; (3)

the brown mucous membrance is not dried or rendered insensitive by the rush of air across it; (4) noxious vapors do not damage it as they otherwise might if they struck it directly.

What are the qualities of smell? The number is enormous, as may be readily shown by sniffing different vegetables, flowers, tobaccos, cooked foods, and even races of people. Odors are usually classified into (1) pure, (2) odors mixed with tastes, (3) odors accompanied by tingling or painful sensations. Of pure odors there are said to be nine classes, as follows:

1. Ethereal, such as fruits, beeswax, ethers.
2. Aromatic, such as camphor, spices, anise, lavender, lemon, rose, and almond.
3. Balsamic, such as jasmine, orange blossom, and vanilla.
4. Ambrosial, such as amber and musk.
5. Garlic, asafœtida, and fishy smells.
6. Burning, such as toast, tobacco smoke, burnt rubber, and the like.
7. The odors of cheese, sweat, goats, and of excrements.
8. Narcotic odors and the smell of bugs.
9. Nauseating smells, such as putrefying bodies emit.

It is quite plain, however, that only a few of these odors are purely affairs of the nose, since nauseating and objectionable odors of all sorts evoke from most people a strong rejection reaction involving the throat and esophagus.

Even though the stimulation of the sense organ of smell is indirect, and produced only because odors are wafted up to the brown mucous membrane, our sense of smell is extraordinarily keen. In other

words, the threshold of smell is very low. It takes only one volume of camphor in 400,000 parts of air, one volume of musk in 8,000,000 parts of air, and 1-100 of a milligram of mercaptan dissolved in 230 cubic meters of air to be perceived as a distinct smell quality. The threshold is also lowered by sniffing the substance, in which case the stream of entering air is directed more forcibly toward the upper portion of the nasal cavity.

Even though the threshold of smell is astonishingly low, exhaustion is sudden and complete, especially after violent sniffing. The nose can be exhausted for any known odor in a very few seconds, especially if it is drawn from a wide-mouthed bottle. But if only one nostril is used, the other remains quite fresh and unaffected. Exhaustion is also selective: the nose may be fatigued for one odor and still remain sensitive to many others. Common spirits of camphor is a gum dissolved in alcohol. If the nose is exhausted for camphor, the smell of alcohol cannot be detected, but iodine will still have its usual effect. It is, of course, to be expected that any substances which tend to dry the mucous membrane of the nose will exhaust it very quickly.

The involuntary exhaustion of the nose to an odor is called adaptation. This phenomenon is extremely common. "It often happens that the inmates of a room are perfectly comfortable and may perceive no fault in the ventilation, although a newcomer from the outside at once remarks that the air is foul." Lovers of onion and garlic cannot conceive why a stranger sniffs so apprehensively upon entering their houses. Our own bodies and clothing have their characteristic and distinctive odor which is lost to us entirely. Indeed, were not adaptation to smell

so easy to acquire, the work of garbage collectors or of medical students in the dissecting room would be permanently disagreeable.

Some odors have the effect of completely deadening our sensitivity to other odors. This phenomenon is called inhibition. The widespread use of deodorants both in liquid and powder form is an example of the application of the psychology of smell to daily life. Odors may also mutually inhibit each other. "If iodoform and Peruvian balsam be mixed in suitable quantities, the mixture is odorless, or, alternatively, if iodoform be presented to one nostril and Peruvian balsam to the other, no sensation of smell may be perceived."

Fusions between smells, between smells and tastes, and between smells and other sensations are very common. Much of the charm of a well-cooked meal is due to the subtle blending of various smells, tastes, and temperatures with one another. Salads, sauces, soups, and other dishes of the table illustrate the rivalry, compensation, and fusion of smell and taste. Nature has also produced many delightful fusions in her fruits and vegetables, but the heat and condiments which factor into the cooked food of civilized man produce many delightful smell qualities which nature falls short of equaling.

Let us now consider the response mechanism involved in the sense of smell. We have already spoken of the receptive surfaces in the upper nasal cavities on the under side of the bony floor of the brain. In these brown patches of mucous membrane are located the dendrites of the olfactory neurones which are attuned to be stimulated by odorous particles. There are fully fifteen hundred of these olfactory neurones in each cavity of the nose. Odorous par-

ticles produce a chemical change in the dendrites, and start thereby a nervous impulse which is carried into the lowest convolution of the brain. Here the impulses are distributed to connector fibers, and are sent out again along motor pathways to much the same muscles of facial expression as are used in the responses to taste. Some motor pathways also lead to those muscles which open the nostrils in order to sniff the odor more enthusiastically, or to those which firmly close the nostrils against any more of the odor.

Changes of expression are commonly observed in persons who smell first one thing and then another, and this, too, is olfactory motor response. The hint for this response to smell we derive from the researches of Ferrier, who found that in the lower animals whose sense of smell is extremely keen, stimulation by an electric needle of the switchboards for smell in the brain produced "contortions of the lip and nostril on the same side, i. e., a reaction such as that actually induced in these animals by application of an irritative or pungent odor direct to the nostril." In man, who has practiced holding a more or less impassive countenance, these natural tendencies to make amiable or fierce faces in the presence of odors have been well-nigh completely unlearned.

This, however, leaves unexplained just how our three thousand smell neurones function in the exhaustion, adaptation, fusion, and inhibition of smells. But, since the actual sensory surface where odors are received is so completely out of our reach, all such questions will have to remain unsolved until more refined methods of experimentation than we have at present shall have been devised.

CHAPTER IX

VISION

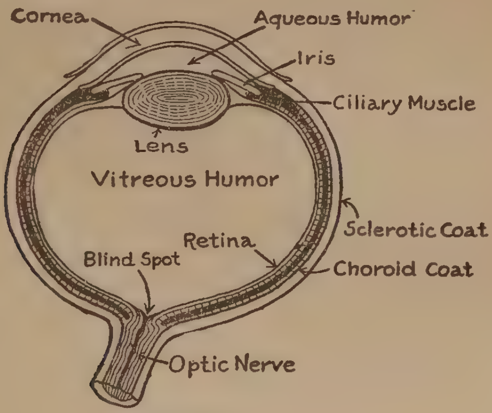
VISION is called the highest of all the senses, not simply for the reason that the eyes are located so near the top of the body, but rather because the eyes have greater natural endowments, and greater possibilities of development than have any other of our many sense organs. No other sense organs get so many different stimulations at one time as do the eyes, or receive impressions from so great distances. Indeed, the field of vision is so large and so replete with variety that it is practically identical with the field of consciousness. The number of names for colors is almost as great as the number of all other sense qualities put together. In addition, the trained eye takes in at a glance the shapes of things and their movements, sweeps the wide horizon, and even learns to measure the distances of the stars. No other sense organ is capable of such variety and completeness of function. Moreover, from this faculty of seeing we derive a thousand important words having social, intellectual, and even spiritual significance. A few examples of these are the terms "eye-witness," "inspector," "leer," "evil-eye," "perspicacity," "insight," "discernment," "speculation," and "seer." And finally, to the improvement of no other sense has man applied so much of his inventive skill, for our telescopes, microscopes, and periscopes are really additional and detachable sense

organs which we fasten in front of the eye in order to increase the range, scope, and nicety of its powers. In consideration of all these facts, vision is rightly regarded as the highest of all man's senses, the intimate workings of which we are now to examine in some detail.

The eye is a little photographic camera, with its shutter, lens, and sensitive plate. The sensitive plate is called the retina, composed of nervous tissue which almost covers the inside of the eyeball. The retina lies against the choroid membrane, a non-transparent coat which nourishes the eye, and has some nerves and muscular fibers. The outermost coat (seen at the front as the "white" of the eye) is the sclerotic membrane, tough and non-transparent. The eye is mounted in a bony socket, lined with fat, and is kept distended into a sphere by the pressure of the liquid within. The sclerotic coat is modified at the front of the eye into the transparent cornea, which is really the lens. Behind the cornea is a liquid known as the aqueous humor; behind that is the iris or colored part of the eye, which is a modification of the choroid coat and acts automatically as a diaphragm; and behind the iris is located the double-convex lens inclosed in an elastic capsule, and altered in its shape by means of muscles. Behind the lens is a heavy liquid, the vitreous humor (so called from its resemblance to molten glass) which keeps the eyeball spherical. The retina, or self-renewing sensitive surface, contains the true receptors for light stimulation. These are two kinds, called from their appearance under the microscope, the rods and the cones. At the back of the eye and near the nasal side there enters a heavy cable of connector and motor fibers, the optic nerve, which dis-

tributes its branches to connect with all the rods and cones.

To the outer surface of the sclerotic coat are attached six muscles for the purpose of protruding the eye, drawing it inward, and revolving it this way and that in its socket. The lids of the eyes are parts of a sphincter muscle whose variety of contractions, as evidenced by facial expressions about the eyes, are almost infinite.



THE EYEBALL

Some errors of vision are due to a misshapen eyeball. If the cornea is not evenly shaped and symmetrical over all its curvature, astigmatism results. This defect is corrected by glasses whose curvature compensates for the misshapen cornea. If the eyeball is too long, so that the focus of light rays from the lens cannot reach the retina, the eye is near-sighted or myopic. If the eyeball is too short, so that the light rays are focused by the lens on a point behind the retina, the eye is far-sighted or hypermetropic. Opticians correct these defects of shape

with lenses that act to modify the focusing of the lens of the eye so as to project the light rays clearly and exactly on the retina.

The iris or diaphragm is automatic in its action, and responds chiefly to the intensities of light. When a bright light is brought near to the eye, the pupil contracts; in a dim light it dilates. These movements are controlled by two muscles, one with circular fibers (a sphincter muscle), the other muscle containing radial fibers whose function is to dilate the pupil. The iris also responds somewhat to the distance of the object away. If the eye looks at a near object, there is always an accompanying contraction of the pupil; similarly, when the eye is focused on a distant object, the pupil dilates. Certain drugs also affect the iris. Belladonna, for example, produces extreme dilation. The dilation and contraction of the iris is caused by two different nerves which have switchboards in the brain proper. When one nerve is active the other is passive, and vice versa. Such functioning is termed *reciprocal innervation,* and is a law of the whole nervous system. When the flexor muscles of the hand are contracted, the extensors are relaxed; when the extensors are contracted, the flexors are relaxed, and so on throughout all the various limbs and organs of the body. It is only in unusual cases that both sets of muscles are simultaneously activated. These two iris reflexes are very important. Dilation occurs in the dark in order to allow a larger amount of light to enter the eye, while contraction saves the eye from too bright a light, and also sharpens the pictures which are cast on the retina.

The function of the lens of the eye is to focus the entering rays of light clearly upon the retina. A camera is focused for different distances by alter-

ing the distances between the lens and the sensitive plate. This is impossible in the case of the human eye, since the lens is always the same distance from the retina. How, then, does the eye focus for different distances? The lens automatically alters its shape—for near objects it becomes thicker, and for far objects thinner. This marvelous little device is called the *ciliary reflex,* and its function is termed *accommodation.* The lens is highly elastic, and is inclosed in a membrane which tends to pull it flat. At the edges of the lens there are muscles attaching it to the choroid coat called the ciliary muscles. When we look at a near object, these muscles contract, and allow the lens to assume its normal, roundish shape. When these muscles are relaxed in far vision, the lens is kept flat by the pressure which the enveloping membrane exerts upon it. "Accommodation for the near object is thus the more active change, since it involves contraction of the ciliary muscle. When we look far off, we simply let our eyes go passive." The iris is also affected by accommodation. "When the eye is adjusted for distance, the iris is flat; when it is focused on a finger held close, the iris is pushed forward by the lens."

There are neither rods nor cones at the place where the optic nerve enters the eye, and consequently this area is not sensitive to light. It is known as the blind spot. If you will hold up this book about a foot from the face so that the cross is directly in front of the left eye, and if you will close the right eye, and fixate the cross steadily and unwaveringly with the left eye, the black disk cannot be seen. (The book may have to be moved backward or forward a few inches to make the disk vanish.) If now you open both eyes, the disk will be plainly

visible. Moreover, if you now rotate the book so that the cross is at the left of the disk, and fixate it with only the right eye, the disk will again disap-

pear. This shows that the blind spot is on the nasal side of either eyeball, and also demonstrates why we are not conscious of either of our blind spots in ordinary vision. For what one eye sees not, that the other eye sees, since a line drawn from the blind spot of the right eye through its lens points toward the extreme right, and a similar line from the left blind spot points toward the extreme left. Furthermore, even with one eye the blind spot is rarely noticed because our eyes are always moving about in their sockets, immediately restoring to vision that which a moment ago had disappeared. Besides, we know that this defect of the eye does not really make any difference to the environment—we do not believe

TEST FOR THE EYE'S BLIND SPOT

that there are any such holes in space. Consequently, if the left eye alone now fixates as before the cross on the right, the center of the checkerboard will not disappear! We simply refuse to disbelieve in its continuity.

The blind spot is not, however, the only part of the eye where vision is imperfect. If the single eye looks steadily at a point on the wall about three feet away, and small patches of various colors are shown clear out at the edge of the field of vision, they will not be judged correctly. But as these patches of color are moved in along the wall nearer and nearer the fixation point, their true colors will gradually become manifest. Blue and yellow will first be distinguished, and after them red and green. At the fovea, or spot of clearest vision on the retina directly behind the center of the pupil, all the colors are seen. The term *color zone* is used to describe the extent of the retinal surface that responds to color stimulation.

We are totally blind to all colors at the outermost edge of the field of vision, unless the stimulation is very intense, or unless we are familiar with the color of the object. In the latter case we use the term *memory color* to describe the phenomenon. Memory colors may also be experienced on a dark night. When we enter our own houses, we see the rugs, curtains, and upholstery as green, blue, or red, whereas if we enter a stranger's house, it is not until the lights are turned on that the true colors of things become manifest. Memory colors also play a part every cloudy day or every evening under the lamp. White paper under a yellow electric light still looks white to us, even though its effect upon the eye is to produce yellow. The "real color," as we call it, is recollected from our noonday experiences with the bright sun overhead.

There are two kinds of receptors in the retina, the rods and the cones. The cones are the receptors for the spectrum colors—red, orange, yellow, green,

blue, and violet. The rods are the receptors for white, gray, and black. But, while there are six colors in the rainbow, there are in psychology only four pure, or primary colors, red, yellow, green, and blue. Orange is for the psychologist a mixture of red and yellow, and violet is a mixture of red and blue. All other color effects whatever are produced either by mixing the primary colors together, or by mixing primary colors with some of the white-gray-black series. Yellow and green produce canary yellow, green and blue produce robin's egg blue, and red and black produce brown, and so on through a myriad combinations.

In any color effect we recognize these three factors: (1) hue, the definite color quality, such as red, blue, or violet; (2) *tint* or *brightness*, as is illustrated by the terms *light* blue and *dark* green; and (3) *saturation*, that is, the depth or weakness of the definite color. Navy blue is more saturated than is sky blue, and hunter's green more saturated than lemon yellow. On the physical side hue is determined by the *length* of the ether waves exciting the retina. Proceeding through the spectrum from red to violet, the wave lengths grow shorter and shorter. Likewise, tint is dependent upon the *amplitude* of the ether wave, and saturation is dependent upon the *form* of the wave. The simplest form goes with the greatest saturation. Since every color is more or less bright, the cones are never stimulated without the rods being also stimulated at the same time.

The retina exhibits the peculiar property of continuing the effect of the stimulation after the stimulus has ceased to act upon it. In physics this would be called momentum. The effect thus produced by the retina is termed an *after-image*, of which in

vision there are two kinds—positive and negative. These after-images are often taken for reality, in which case we have a *visual hallucination.* If you will stare fixedly for a half minute at the palm of the hand illuminated by an electric light, and then turn off the light, you will see an image of the hand which will move about as you move your eyes this way or that. This is called an after-image ghost, and is a hint of the nature of all ghosts whatsoever. Again, if you look at the yellow sun very briefly in winter, and then turn your gaze upon the snow, you will see greenish-blue spots wherever you look. These are visual negative after-images, being of the complementary or antagonistic color to the stimulus. Usually, with only a moderately intense stimulus, and with brief fixation, positive after-images will be produced; with long fixation, negative after-images will result. However, the background upon which the image is projected makes a difference to its character. A gray stimulus will produce a darker after-image with a white background than with a black background. It will be interesting to try this experiment before you read a line further.

One of the most curious phenomena of all psychology is this ability of the retina to produce complementary color effects within itself for the purpose of neutralizing the effect of the external color stimulus. Indeed, the eye is so extremely sensitive to light and color that it even keeps continuously moving about in its socket to prevent any stimulus from affecting any spot on the retina for too long a time. For every color stimulus disturbs (i. e., breaks down) the chemical stability of the retinal substance. During sleep the eye comes quickly to its natural state of rest. If you close your eyes, you will

perceive what this condition of retinal rest is. For, even with tightly closed eyes, we still get a curious retinal impression which cannot be described either as black or as just nothing at all. It is a dull, neutral gray, "the intrinsic light of the retina." Now this particular neutral gray, which, by the way, is the only absolutely comfortable (unstimulated) condition for the retina, is the state toward which the eye is always tending. Consequently, the formation by the eye of negative after-images is simply an attempt to neutralize the stimulus, i. e., to bring the eye back to normal again. Here, then, we may find a law of vision, which is, that *the eye always tends to return to color neutrality or equilibrium.*

This law we see illustrated at once in the phenomena of color mixture. If we take a disk half blue and half yellow, and revolve it rapidly on a color wheel, the result will be gray. The yellow and blue have neutralized each other. The same neutralization can be seen with black and white, purplish-red and bluish-green, and in fact with a great number of other combinations. In each case antagonistic chemical processes have been actuated in the retina, with the result that we see nothing of the stimulus at all. The various stimuli cancel each other, and, so far as color is concerned, the eye is thrown out of action. Likewise, a disk divided into four parts occupied respectively by yellow, blue, red, and green, or a disk divided into six parts and occupied by red, green, blue, yellow, black, and white, will produce the same cancellation of all the various stimuli, leaving only the neutral gray to produce its effect. Color mixture is, in many cases, simply color cancellation. But if red and yellow are thus whirled about, orange will appear; if red and blue, violet;

and so on throughout a long list of nonantagonistic colors. From these various results the following laws of color mixture have been derived:

1. For every color there can be found an antagonistic or complementary color, which, when mixed with it in the right proportions, will produce gray.

2. The mixture of any number of pairs of complementary colors will likewise produce gray.

3. Noncomplementary colors when mixed together produce a color effect which is the average of the two colors used.

Such "color blindness" as the normal eye experiences in the mixture of complementary colors some people experience all the while. It is much more common with men than with women. It is also congenital as well as incurable. There are usually two forms of it—total color blindness, where the eye is blind to all hues, and partial color blindness, in which the eye is unable to see red or green. All these colors look gray, and are seen as either light or dark gray according to their tint. "Partial color blindness was first brought to scientific notice by the English chemist John Dalton in 1798. Dalton was a Quaker, but made no objection to wearing the scarlet gown of a doctor of laws, because, as he said, 'to me its color is that of nature—the color of those green leaves'; it is needless to remark that he did not see green either! The defect is practically important for pilots and signalmen, who have to distinguish red and green lights."

We have just seen that some colors produce antagonistic retinal effects and thus tend to destroy each other, and also that, when some retinal processes are excited and the color stimulus is with-

drawn, the complementary color takes its place. This law of the retina—that it tends at all times to come to a color neutrality—is illustrated by still another phenomenon called *color induction.* If one looks at a white window curtain at the edge of a yellow window blind under the proper illumination, the white curtain will be tinged with blue, the complementary of yellow. Similarly with a green blind there will be an induced reddish tinge in the white curtain. Again, if you will place any colored square upon a gray background, and look at it fixedly for a few seconds, the patch of color will be surrounded by a fringe of the complementary color. (Indeed, this is the only scientific way to find out just what the complementary of any color is.) The fixating eye cannot be kept exactly steady, and it is for this reason that the complementary will often appear to "spill over" the sides of the fixated patch of color. This induced color is, of course, produced in all those parts of the retina which are being affected by the stimulus, and it really mixes with and alters the effect of the hue of the stimulus color. It is for this reason that the fixated patch gradually loses its original vividness—induction produces neutralization. If now, after having "filled the eye" with the stimulus, you take away the patch of color and fixate the gray cardboard, it will appear everywhere you look to be tinged deeply with the complementary. By this same method curious effects can be obtained. Red gives a green complementary, and this induced green can be made to mix with yellow, blue, or white, or with any other hue or tint that you please. If it is mixed with white, it will, of course, make it appear a light green. Colored shadows are examples of induced colors. A red light obstructed by an opaque object

will make by induction a green shadow, and a yellow light under the same conditions will give a blue shadow. The green and blue shadows can also be made to mix, producing a blue-green, according to our third law of color mixture.

Color contrast and color induction are two of the permanent psychological phenomena of life, and they factor largely into landscape gardening, dress-making, painting, and theatrical illumination. "All the various lights and colors of the landscape stand out by contrast against one another; the eye makes their differences greater than they ought physically, from the nature of the stimuli, to appear. Contrast is effective at once the moment you cast your eyes on the landscape. Actually, if you stared at the landscape long enough without moving your eyes, you would finally see nothing but neutral gray. This leveling down of all lights and all colors toward neutral gray is called adaptation." After the matinée, when the eye has become adapted to the yellow of the electric lights of the theater, all objects outside have a bluish tinge. If all the lights in the theater had been red, the environment outside would have looked green.

What now is the nature of the nervous and response processes which make color vision possible? While this question cannot be answered in all its detail, owing to our lack of precise information upon the subject, the following facts are nevertheless fairly well established.

1. All stimulation of the retina disturbs its chemical stability. Vision is thus a true case of the transformation of energy, just as is every other mental process whatsoever. The retina responds to light and color by altering its chemical constitution. The

clearest example of this is found in our responses to all bright lights. There is a substance in the retina called the visual purple, produced by the rods in the eye. This substance bleaches under strong light, and swells, covering the rods and throwing them out of action until either the eye closes or the stimulus is withdrawn. Here is true response—a chemical activity produced by the intensity of the light.

2. All light and color stimuli produce electrical changes in the retina, the nature of the change varying with the wave-length of the light.

3. Colors affect not only the retina, but the blood pressure, the breathing, and even in some cases the digestive processes. This last, however, is largely due to association. We inseparably connect certain colors with agreeable or disagreeable events or people, and react thereafter to the colors in terms of the things for which they stand in our experience.

All such chemical and electrical changes must, of course, affect the fibers of the optic nerve and produce brain changes of a definite character. Indeed, it is supposed that the motor fibers in the optic nerve bring about some of the responses which take place in the retina. But just what such brain changes are we do not yet know. It has so far been impossible to use the microscope on living brain tissue. On the other hand, the microscope might not reveal anything important. Perhaps the retinal activities are the only significant factors in the visual response.

One of the most important switchboards of the brain is the so-called visual area, located at the extreme rear of the cerebrum. If this area is injured or destroyed, blindness results. This is not to say, however, that we *see* with that part of the brain. We *see* with the whole optical mechanism—eye, optic

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A COLOR MIXING TEST. Both disks are colored alike; the one at the right is stationary; the one at the left is revolving and shows the results of the blending of the two colors in the given proportions.

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TESTING THE FIELD OF VISION. A color perimeter is used to measure the field of vision of the eye and the color zones of the retina.

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An Experiment with the Galton Bar. It is used to test the perception of small differences in length.

nerve, visual area, and so on, the loss of any one of which can completely destroy our sight. It is only because sensations were thought to take place nowhere but in the brain that this area was called the "*center* of sight." *There is no one center of sight.* Vision is a response process, and it requires eye and brain equally in order to function to the best advantage.

Vision is the highest of all the senses because of its importance for surveying the whole environment. The eye is the sentinel which brings either alarm or peaceful report to the whole mental and physical being. Needless to say, the sense of sight has power to arouse the whole kinetic system and to put into play the largest activities of which we are capable. For the eye is used not only to make love, but to engender hate; to start scientific investigation, and to express with equal facility recognition and farewell.

CHAPTER X

HEARING

HEARING, like sight, is called a higher sense on account of the fact that it gives us so many and such varied impressions from wide reaches of the environment. In one respect hearing may be regarded as superior to sight; for, while the eye gets stimulations only from objects in front and a little to the sides of the head, our sense of hearing may be stimulated by sounds that come from any direction whatsoever. In this respect the ears of men are like the eyes of birds, for the birds' eyes are so placed in their heads as to enable them to see with equal facility objects either directly in front or behind. Nevertheless, the ears are inferior to the eyes in three principal abilities. In the first place, since light travels so much more quickly than does sound, the things we see even at relatively great distances are happening while they stimulate us, whereas sounds originating no more than a mile away take several seconds to come to our ears. Again, the field of vision may include thousands of distinguishable colors and shapes, whereas we do well if we are able clearly to differentiate a dozen varied sounds at a time. And, finally, the effective range of vision covers immensely greater distances than does the range of hearing. For while we may see during an eclipse magnificent explosions on the sun, our ears are unable to pick up even the slightest hint of the

concussions which are lost in the abysses of space. Let us first briefly examine the organ of hearing, and then consider the response mechanism by which our consciousness of sound is generated.

The ear is divided into three portions—external, middle, and internal. The external ear is partly visible in the expanded and wrinkled funnel on the side of the head, from which a tube penetrates the bony wall of the skull. This tube is closed by the ear drum, a membrane which separates the external from the middle ear. The function of the funnel and tube is to collect sound waves. The tube and the drum also have a protective function. The tube is curved, and the drum is set slantwise across its end, so that if sharp grains of sand, for example, are blown into the ear they will be prevented from doing damage. Nevertheless, many an ear drum has been punctured by sand grains or other sharp objects blown into it at a high velocity. The tube of the external ear is lined with wax as an additional protective measure.

The drum of the ear vibrates sympathetically with the sound waves that strike it. This membrane is made of tough, radial fibers, and has the peculiar property of being "a-periodic," that is, it has no definite vibration rate of its own, but it can transmit any rate of vibration indifferently. The question may arise: "How is this known, since the ear drum cannot be seen under ordinary conditions?" The answer reveals how ingenious and persistent scientific experimentation has become. The man volunteering to be the subject of the experiment allowed a straight tube to be inserted into his ear passage, and a tiny mirror no bigger than the head of a match to be glued upon his ear drum. Then a fine beam

of light was thrown upon this mirror. Now, light is the most delicate of all our means for measuring motion. The light beam, reflected from the mirror, gave instant information of whatever vibratory motions the ear drum was manifesting. This light beam was photographed upon a moving film, and by this means the a-periodic character of the drum was discovered. With a sharp sound the drum at once became tensed, while with low, broad sounds it relaxed and vibrated more extensively. This function of the ear drum is called *adaptation.* If it did not tighten in order to vibrate to high, sharp sounds, it might be split clear through.

This tightening and relaxing of the ear drum is functioned by the apparatus in the middle ear, which begins at the inner side of the ear drum. There are three little bones in the middle ear called, after their resemblance to the shape of the objects, the hammer, the anvil, and the stirrup. One end of the hammer is attached to the center of the ear drum. At the other end of the hammer a short, powerful muscle fastens it to the side of the bony cavity of the middle ear. When this muscle contracts, it so rotates the hammer bone that the ear drum is literally twisted tighter. The hammer bone is fitted into the anvil, and the anvil into the stirrup. It is by means of this chain of small bones that sounds from without are conducted to the receptor organs of the internal ear. There are two little muscles which attach the hammer and stirrup to the bony wall of the middle ear. These muscles sharply contract whenever our ears are struck by a shrill sound or when we set ourselves to listen very attentively. To the practiced observer the squeeze in the ears caused by this contraction is quite noticeable.

From the middle ear a tube extends to the throat, which is called, after its discoverer, Dr. Eustachius, the Eustachian tube. The outer ear is filled with air, and by means of the Eustachian tube the air is let into the middle ear. We swallow sometimes in order, by opening this tube, to equalize the air pressure on either side of the ear drum. Explosions and artillery firing often catch people unawares and rupture their ear drums because the air pressure on one side suddenly becomes thousands of times greater than it is on the other. Thus, while ordinarily to leave the mouth hanging open is disadvantageous, both on account of the danger of foreign substances and vagrant insects getting into it, and because of the impression it gives of weakmindedness, in the neighborhood of sharp and violent concussions it becomes the height of wisdom to do so. Swallowing in order to equalize the pressure on either side of the ear drum is advisable while making rapid ascents in elevators or descents into mines. Since the Eustachian tube opens into the throat, other things than air may enter it, and hence it is dangerous to blow the nose too violently, especially if there is any likelihood of infection in the nose and throat passages.

The external and middle parts of the ear are filled with air, while the internal ear is filled with a liquid called perilymph. The foot of the stirrup fits into a little oval window in the internal ear, and the joint is closed by a delicate membrane that makes it watertight. The internal ear is called the labyrinth, an elaborate bony cavern, in which there lies a membranous sac filled with a liquid called endolymph. Only one of the many important organs of this labyrinth is supposed to be used in hearing. It is called

the *cochlea,* and is a tube coiled up like a snail shell for two and a half turns. The cochlea is divided along its winding course by a ridge of bone and a thin membrance called the *basilar membrane.* Vibrations of sound shake the stirrup and cause it to be pressed into the oval window. Below the oval window is the round window, facing the middle ear, and also covered with a membrane. Whenever the stirrup presses into the oval window, the liquid which is thereby displaced causes the round window to be bulged out. Moreover, the thrust of the stirrup is transmitted through all the liquids of the internal ear. On the basilar membrane is located a curious little mechanism called the organ of Corti. This consists of a series of sensitive cells, at the top of which are hairs projecting into the endolymph. Over the hairs hangs a loose membrane, the *tectorial membrane.* When you stir sea water with a stick, the seaweed on the bottom sways to and fro. Similarly, when the stirrup shakes the endolymph, the tectorial membrane is tossed about, and its edge strikes the hair cells of the organ of Corti. At the base of this organ the nerve cells for the reception of sounds are located, and in these nervous impulses are aroused and transmitted to the brain.

Now, just as we have found in the case of every other sensation we have so far studied that there is no consciousness of the stimulus until brain activity has been transformed into muscle activity, so is it the case with hearing. The auditory nerve leads to the spinal cord, and there it ends. Connector fibers lead from that terminal to the neighborhood of the already well-known fourth ventricle of the brain near the medulla, whence the impulse is transmitted at once to those motor nerves which regulate

the functioning of the speech organs. And these speech organs, including the larynx, the vocal cords, the tongue, and even sometimes the lips and cheeks, are straightway thrown into activities which, if allowed full swing, would actually reproduce the sounds we hear. *The response to any sound, then, is a tendency on the part of the vocal apparatus to duplicate it.* We may not, of course, be aware of the innumerable tensions which the speech organs are then undergoing, except, perhaps, when we have listened to shrill sounds and clangor until our throats feel tired.

Mind is again thus seen to be activity, and in the case of hearing the action is an imitative one. To be sure, we can hear some sounds which we cannot truly duplicate, just as we can "think" tones beyond our singing range, but in all such cases *only a few* rather than *all* the conditions for reproducing the sounds are present in the vocal machinery.

The nature of the reaction to sound is responsible for many errors in listening. How often it is reported, "That is what I heard him say," meaning in psychological terms, "Those words are what my vocal apparatus subconsciously uttered while he was talking." We sometimes call foreign languages "jabbering," because they fall upon ears and stimulate brain mechanisms totally uneducated to respond to them in kind. It is for this reason also that much testimony in the court room is worthless—the witness often hears only in terms of what he would like to report, and his wish to report dominates his vocal responses. Here, then, we have the first hint of the nature of *prejudice* or *bias* as applied to things heard and spoken.

There are three distinguishable kinds of sounds—tones, noises, and the vowels of ordinary speech. The tones are the simplest of these three sounds, and are characterized by pitch, loudness, timbre, and volume. Pitch means that the note is high or low in the musical scale, that it belongs to the treble or to the bass region. Pitch is due to the number of vibrations per second which reach the ear, and corresponds to the hue of colors. Loudness is due to the amplitude of vibrations, and corresponds to the brightness of visual sensations. Timbre is related to the saturation of color, being due to the complexity in the form of the sound wave. Volume is a word which refers to either the source of the sound or to its ability to throw a large or small inclosed space of air into sympathetic vibration. "The highest note on the piano seems shrunken, narrowed, pointed, as compared with the deepest note in the bass." Noises are not all unmusical; some of them have a very definite pitch. A small, hardwood stick sounds shriller when dropped on a wooden floor than does a heavy log of wood. Noises also have timbre and loudness, as well as volume, as can be shown by dropping various kinds and shapes of metal and wood blocks and bars on a sounding surface. In reality, noises are crowds of tones, each so short in duration as to be indistinguishable as a definite pitch. Vowel sounds are tones regularly interrupted many times a second. The different vowels, U, O, A, E, I, and so forth, get some of their quality from their pitch and placement in the mouth, and the rest of it from the manner in which their basic tones are interrupted.

We distinguish three thresholds in auditory sensation. Less than about thirty vibrations per second

cannot be recognized as a tone, and hence this number is called the lower threshold for pitch. Vibrations more rapid than about 30,000 per second cannot be recognized as a tone, and so this number is called the upper threshold for pitch. Moreover, as we have just seen in the case of noises, a tone must be maintained a certain small length of time before it is heard as a definite pitch, and this time interval we may call the duration threshold. The latent period of sound is much longer than that of sight, and this is due to the inertia of the ear. It apparently takes an appreciable interval of time for the ear drum and ear bones to be started vibrating steadily at a definite rate.

The musical scale is an example of a purely psychological phenomenon. The sounds of nature are, as we hear them, more or less haphazard, and even in many cases a confused and disordered medley, whereas the musical scale represents man's attempt to put some order into this natural chaos. Nevertheless, our musical scale is built upon natural laws, even though many of nature's wind-and-water harmonies are disregarded in the making of it. For every note we recognize as having a definite pitch in the scale is derived from what is called the "natural system of harmonic overtones." For example, if a low note is struck on the piano, its richness and fullness are not due to the vibration rate and character of the single note sounded, but to the sympathetic sounding of many other and higher notes at the same time. And if we seek to determine what those other notes are we shall find them all to be the notes of our scale. If the note C below the bass clef be

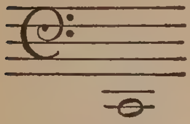

Fig. *a*

struck and the dampers be lifted, there will be sounding the other tones, represented in Figure b. If you will count and arrange these various tones, you will find them to include the following: c, d, e, f, g, a, b-flat, which will, when played in succession, make the recognized musical scale. Man thus selects out of nature's storehouse of musical effects those which his ear prefers as the most orderly and pleasing succession of tones, and makes them the basis for his musical harmonies.

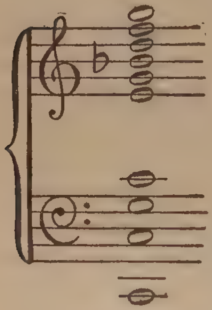

Fig. b

Harmony and dissonance are due to the presence or absence of what is called *fusion* between tones. Tonal fusion is like lemonade — a new quality is generated out of the union of the various stimulations. Tonal fusion is most readily gotten by the octave (c—c), which seems to many people like one note instead of two, next by the fifth (c—g), then the fourth (c—f), then the third (c—e) and sixth (c—a), while the least readily fusible intervals are the minor third (c—e flat) and minor sixth (c—a flat), the minor seventh (c—b flat), major seventh (c—b natural), major ninth (c—d natural), minor ninth (c—d flat), etc. The musical chord of three or more notes is a case of fusion. The simple and pleasing melodies to which we attach so much sentiment are usually harmonized by means of chords with easily fusing intervals.

The difference between the major and minor chords is largely a psychological one, and involves a slightly more complex response process than we have hereto-

fore described. If the notes c-e-g be struck on the piano, and after them the notes c-e flat-g, viz.:

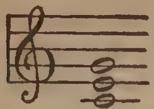

Fig. *c*

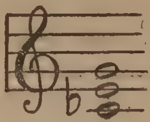

Fig. *d*

the difference will appear to be much greater than can be accounted for on purely physical grounds, in short, the whole psychological character of the second chord seems to be profoundly different from that of the first. Why is this so when only one note has been altered? This is the answer: The upper and lower notes that remain the same (the c and the g) do not give to either chord its peculiar quality. It is the middle note alone that determines what effect the whole combination will produce. But this does not yet answer the question as to why the second (or minor) chord gives such a strikingly depressing effect. It sounds sad, and evokes a certain longing and inwardness in the listener which the major chord does not. The answer to this question is that it is the middle note of the chord to which we respond with the greatest expenditure of energy, and so when that note is lowered a semitone (to e flat) it produces a motor effect upon us as of something being pulled down. Now this pulling down is really a withdrawing reaction, a physical depression, if you will, and it is this physical depression which produces the mental depression. (Actually, we ought to say that the physical depression *is* the mental depression.) Furthermore, this depression has been associated in the minds of adult persons with various sentiments of longing and sadness—an association

easy to form on account of the effect of the minor chord upon our whole physical nature.

There are many other interesting auditory phenomena, but these we must omit from our chapter. It remains, however, to speak of the so-called center for hearing in the cerebrum to which certain important nerve fibers lead from the medulla, where, it will be remembered, the nervous impulses from the inner ear are sent to the vocal organs. The auditory area in the cerebrum is a switchboard for associations that we make between hearing and the other senses. For example, the auditory area is essential when we remember that this particular sound is made by a bell, that one by a coal shovel, and the other one by a squeaky shoe, and so on. And so important has the meaning of a sound become to us that we are almost unable to hear those sounds that we cannot *recognize.* Hence the importance of the auditory area in the cerebrum—by it we are enabled to interpret sounds that would otherwise be meaningless. Of course this auditory area is connected with fibers to all the other sense centers, for, like all other association switchboards, it is important solely because it continuously gives and takes impulses to and from other parts of the brain.

CHAPTER XI

TOUCH, WARMTH, COLD, TICKLE, AND ITCH

IN the classification of sensations in Chapter VI it was shown that there are many more than the traditional five senses. In this chapter we find that the old "sense of touch" includes at least six different kinds of sensitivity. These are called (1) pressure, (2) warmth, (3) cold, (4) pain, (5) tickle, and (6) itch. Besides these we have the experience known as "heat," the creepy feelings that go with a shiver and with the rush of blood to the face, and perhaps one or two other distinct dermal experiences. Some of these, however, we shall find to be mixtures of the others, such as heat, tickle, and itch. Pressure, warmth, cold, and pain are called the simplest or most elementary skin sensations. The sense of pain has so great a psychological importance that we reserve a separate chapter in which to discuss it.

The skin is the oldest of all our receptive surfaces, and is possessed by every living creature, including the plants. The higher senses are evolved from it: the eye originated in a spot of pigment on the skin, and the ear evolved from a membrane which developed on the outer surface of the body. The skin is revealed under the microscope to consist of a topmost layer of dead tissue about 1-10 millimeter thick. Were this topmost layer not dead, our toes would grow together. Below this there is a great

variety of structures, including sense organs and capillaries. The skin of the body is one of the great reservoirs of blood. During sleep the skin is surcharged with blood, and hot baths also bring it to the surface.

The sense of pressure may be demonstrated in at least two ways. One is by touching the skin lightly here and there with either a blunt lead pencil point or a coarse bristle; the other method is to lift a hair gently until the skin is seen to be raised at that point. Indeed, if we avert our face while some one else is testing our pressure sense, we cannot distinguish the difference between pressure with a bristle or pull on a hair. The sensation of pressure is not found everywhere on the skin, surprising as this may seem. If you explore the skin of another person with a blunt object, point by point and line by line, you will find that there are many spots where no sensation will be registered. Of course the exploration must be extremely gentle and uniform to demonstrate this fact.

What, now, is the nervous mechanism of touch, and what is the motor response without which pressures and pulls cannot be felt as sensations? Below the surface of the skin are many tiny little organs for the reception of pressure, about which the dendrites of sensory nerves are twined. When a touch stimulus is applied to the skin, its surface is either depressed (as in the case of the blunt pencil point) or lifted (as when a hair is pulled), and this deformation disturbs ever so slightly the position of the tiny sense organs and the nerve fibers twined about them. This starts a nervous impulse which is carried to the spinal cord and back to the region of the touch spot. Underneath the skin there are strands of muscular tissue, to which the returning motor

fibers lead, and the sensation known as touch is due finally to the slight budges which this muscular tissue undergoes. Of course we are never aware of these tiny muscular budges. What we are aware of is our being touched, and this experience we habitually associate with the stimulus, saying "a *pencil* touched me," "a *drop of rain* fell on my face," or "I feel this *shoe* pressing here," etc.

"Touch is felt at the base of every hair on the body," is the report of a careful and painstaking investigator who explored the entire surface of the human skin. Touch is also found on hairless surfaces, such as the palms and finger tips, the tongue and the lips. The imagination can hardly conceive the number of sense organs and motor responses set into activity when the palms of the hands are laid gently on the surface of coarse sandpaper, to say nothing of the millions of touch spots stimulated when we change in the late fall to heavy winter underwear.

The sense of touch exhibits similar phenomena to those we found in the other senses we have studied. We can find the threshold by measuring the amount of pressure required to produce the sensation. The latent period is very much longer than that of vision. Adaptation to pressures is seen in our unconsciousness of our eyeglasses and clothes. One of the joys of new gloves, shoes, and hats is the restoration to consciousness of pressure sensations that had long been lost. Fusion is easy to demonstrate in touch. A pair of blunt compass points set a quarter of an inch apart and applied to the shoulder or elbow are felt as one rather than two. The surface of the body varies immensely in the fineness of its pressure discriminations.

That the temperature senses, warmth and cold, are distinct from touch as well as from each other may be shown by the following method: "If one will but run over the skin with the point of a rod heated above the body temperature, one will notice that the rod feels warm only here and there at points well separated. If the rod be cooled below the temperature of the skin, cold is noticed at many more spots, about thirteen to the square centimeter, but still wide areas without temperature sensations intervene. While, then, the physicist assures us that cold is nothing but the absence of heat so far as energy is concerned, it is undoubted that, physiologically and psychologically, cold is just as truly a distinct sensation as warmth. Not only is it proved by mapping the spots that the temperature senses are distinct, but the result is confirmed by a number of related facts: (1) Stimulation of a well-marked cold spot always gives cold only, no matter what the source. Pressure, the electric current, even the warmth obtained by concentrating the sun's rays upon the spot by a small lens, all give the sensation of cold. (2) Certain parts of the body, the cornea of the eye, e. g., lack warm spots altogether, and there are relatively large areas where cold spots are lacking. (3) Certain chemicals, e. g., menthol for cold, carbon dioxide for warm, will excite one sort of spot, but not the other."

The motor response to cold is plainly visible in the phenomenon called "goose flesh," where the separate hairs are all erected and the surface of the skin covered with temporary pimples. Tiny sense organs, especially attuned to receive the temperature stimulus, transfer an impulse to the brain by a sensory nerve, which impulse is again returned to the area

stimulated by fibers of the sympathetic system (a special set of motor pathways whose function is to get quick and direct action upon various muscles and glands). Attached to all hair roots are tiny muscles known as the *pili erectores* (erectors of the hairs), which contract to elevate the skin so as to enlarge the capillaries and let more blood into them. This defense mechanism against cold is one of the most ingenious and fascinating devices of all the body machinery.

The response to warmth is doubtless some action on the part of the surface capillaries (through sympathetic nervous action), for upon the application of temperatures warmer than the skin the blood is drawn to the surface.

Adaptation to warmth and cold is shown in our becoming acclimated. It may also be demonstrated by the following experiment: Place one hand in hot water and the other in cold. As soon as the temperatures cease to be felt, place both hands quickly in a pot of lukewarm water, when it will be sensed that the hand formerly adapted to cold will feel warm, and the hand adapted to warm will feel cold. It is also interesting to study the sensations produced in the two hands (before the change is made) by moving them about in the water to which they are being adapted. The *pressure* of the water will restore to the half-adapted hand the original temperature sensation.

"The experience of *heat*, curiously enough, is a blend of warmth and cold; there are no heat spots. It may be observed in this way: If you apply a surface of increasing warmth to a region of the skin which has both cold and warm spots, you feel for some time only the warmth; but when the stimulus

has reached a certain temperature, the cold spots, suddenly and paradoxically, flash out their sensations of cold; and the blend of warmth and of paradoxical cold is felt as heat. Cement a smooth copper coin to a handle, and apply it at gradually increasing temperature to the middle of the forehead just under the hair; you will presently find the heat. Or, if you cannot do that, note the shiver of cold when you next step into an overhot bath."

Tickle and itch are, perhaps, a little harder to analyze than is heat. Tickle is supposed to be produced by very light stimulation of a field of pressure organs. Itch, on the other hand, is regarded as due to the light stimulation of a field of pain organs.

Professor Titchener calls the skin a "shifty witness" of sensation. He says: "When we compare these results with the show that the skin makes as a sense organ in everyday life, we can hardly help bringing against it the charge of dishonesty. The pressure spots give us tickle, contact or light pressure, and pressure proper; the pain spots, itch, prick or sting, and pain proper. The cold spots give cold and cool, the warm spots lukewarm and warm; cold and warm spots together give heat; cold and pain give biting cold; cold and warm and pain give burning or scalding heat; and that is all."

There are thus two psychological reasons why all the dermal sensations have been lumped together into the "sense of touch." In the first place, the organs under the skin are not ordinarily stimulated separately, but in groups. This makes differentiation between the separate sensations very difficult. In the second place, as has been hinted before, we have educated ourselves to be more interested in the stimulus than in the resulting sensation, and this

perpetually deters all inquiry into the conscious elements of dermal sensitivity. Why we have so neglected the analysis of our skin sensations is also quite clear when we consider that our first and last business is to become acquainted with the environment and to manipulate it according to our needs and desires. In the face of this need man has found little time for an analysis of his skin sensations or of the mechanisms of response by which they are produced.

CHAPTER XII

PAIN AND PLEASURE

NO other sense has been endowed with such a profound significance for the life of man as has the sense of pain. From time immemorial it, of all the senses, has been taken as the index of disease and the forerunner of death, while the most elaborate incantations, the most fervent prayers, and the greatest scientific acumen of which man is capable have been devoted to its alleviation and relief. Indeed, pain is the only sense which has an equally important place in medical science, ethics, philosophy, and religion. Pain and evil have an inseparable connection. The religious philosophers of India begin by calling pain the fundamental fact of human life, and they devote all the remainder of their systems to its explanations, and devise their religious rites for its atonement. Contrariwise, one of the fundamental doctrines of Christian Science is the absolute unreality of pain, which is said to be the fabrication of an erring mind.

The importance which thus attaches to pain is not to be wondered at, since pain is unique among all the senses. In the first place, there is no specially modified receptor organ for pain. For while there are rods and cones in the retina, the organ of Corti in the ear, taste buds on the tongue, and tiny corpuscles of various shapes for the reception of touch, warmth, and cold, the only receptors for pain are

the free nerve endings—the dendrites of the sensory neurones themselves. In the second place, there is no special switchboard or "center" in the brain for pain as there is for sight, hearing, and the other senses. Again, pain is produced by a greater variety of stimuli than is any other sensation. For not only will the merest contact of a needle point on the surface of the skin above a pain spot produce the wiry thrill that is called skin pain, but all high intensities of stimulation in the other sense fields are generally painful. Too much light painfully blinds us, too much sound painfully deafens, the first whiff from an ammonia bottle is painful, just as is intense heat or cold. In fact, until a comparatively few years ago, pain was regarded even by scientists as only a superstimulation of any of the senses. Moreover, the electric current is invariably painful, no matter to what sensitive surface of the body it is applied. We seem to have developed no organ for the reception of electricity as we have for other forms of the energies of nature, such as light, sound, and temperature. And besides all this, some of the organs of the body, such as the cornea, the ear drum, and the pulp of the teeth always produce the pain response when stimulated.

We can best understand the mechanism of pain through a consideration of its biological importance. To begin with, pain is really a warning to us that some parts of our bodies are injured or out of function. But not all parts of the body give such a warning. For while the accumulation of toxic products, inflammations and burns, tumors and hemorrhages, the strong or prolonged contraction of a hollow organ, and even such sudden alterations of the blood pressure as follow the removal of a tourniquet all

produce pain, yet many other equally important and dangerous stimuli may be absolutely painless. "The deeper viscera of the thorax and abdomen are insensible to pinching, cutting with a sharp instrument, or other mechanical, chemical, or thermal stimuli." Likewise, while surgeons find that the membranes or coverings of the brain are very sensitive to mechanical injury, especially to stretching and pulling, yet "the brain substance itself is quite insensitive to pain from either mechanical or chemical stimulation." Similarly, "tuberculosis of the lungs is painless, while intense pain is associated with tuberculosis of the hip." The sense of pain, then, does not warn of every danger to which the body is exposed.

Now, what is the significance of the fact that only certain parts of the body are sensitive to pain? We find that pain is most intense in "the parts most commonly subjected to attack and to physical injury, such as the tips of the fingers, the palms of the hands, the soles of the feet, the chest, and the abdomen, while the deeply protected portions of the body, such as the liver, spleen, kidneys, brain, and lungs are pain-negative, so a type of infection which is associated with pain when it involves one portion of the body may be painless when it involves another portion."

Here, then, we have the clues to both the specific response requisite for pain and to its biological significance as well. It will be observed that pain is felt best in the extremities and on the unprotected surfaces of the body. Now these parts consist principally of *muscles*. The response which turns stimulations into painful sensations must, then, be principally a muscular response. Let us see what proof we have of the truth of this conjecture.

In Dr. George W. Crile's "A Mechanistic View of War and Peace" occurs the following account of the place of pain in the fighting soldier's experiences:

"Pain as a phenomenon of war exhibits several variations of great interest, the key to which is found in the conception of pain as a part of an adaptive muscular action. Identical injuries inflicted under varying conditions yield pain of unequal intensity. The most striking phenomenon exhibited by soldiers is the absence of pain under the following conditions: (*a*) In the midst of a furious charge the soldier feels no pain if wounded; and sore and bleeding feet are unnoticed. In the overwhelming excitement of battle he may be shot, stabbed, or crushed without feeling pain. (*b*) The blow of a high velocity bullet or projectile accompanied by the heat of battle causes no pain on impact, though there may be a burning sensation at the point of entrance, and the soldier may feel as if he had been jarred or struck. Frequently he first learns of his wound from a comrade. (*c*) In the state of complete exhaustion, in which loss of sleep is the chief factor, pain is quite abolished. (*d*) Under heavy emotion pain is greatly diminished, even prevented."

Now, what is happening in the body of such a soldier to prevent the registration of painful feelings? The answer is twofold: In the first place, the final common pathways of motor discharge are all preoccupied. In telephone parlance, "somebody has the line." There is no energy left to be released and transmitted along those pathways which would function pain if they were set into operation. But what sort of response would be generated if such pathways did finally become active? The answer is that some defensive muscular activity would be set going,

some muscular tensions would be established in the wounded part, such as are plainly manifest in colic, in the wrinkling of the brows and the drawing of the face in toothache and neuralgia, and in the tense twitching of the limbs generally when severe pain is felt. This is the response to pain, the muscular activity without which pain cannot be felt.

Dr. Crile continues: "During the overwhelming activation in a charge the stimulus of the sight of the enemy is so intense that no other stimulus can obtain the final common path of the brain—the path of action. Therefore, if a bullet or bayonet wound is inflicted at the moment when this injury cannot obtain possession of the final common path, it can excite no muscular action and consequently no pain. Hunters attacked by wild beasts testify to the fact that the tearing of the flesh by claws and teeth cannot dispossess the excessive activation of the brain by the realization of danger. For this reason the teeth and claws of the beast do not cause any adaptive muscular response, and therefore there is no pain. In like manner the emotion of fear in the soldier holds possession of the final common path so that muscular action against local flesh injuries is prevented. Not only in war does emotion overcome pain; so does great anger; so does the exaltation of religious fanatics in their emotional rites."

The biological significance of pain, then, is this: That, since muscular action is essential to pain, we feel pain from those injuries which are best helped by rest or by muscular rigidity. Cramps, then, for example, are not only painful—they are the body's own automatic "first aid" measures to bring relief to the overworked or injured part. Similarly with headache—its function is to bring us prostrate in

order that rest and recuperation may come. Pains, then, are not only warning signs, but they are also devices for enforcing rest and hastening a cure.

The fact that harmful stimuli cannot produce pain unless they can get control of the final common path furnishes a useful hint for applied psychology. A person in the dentist's chair may protect himself from pain by two methods. One is to make his body as rigid as possible, and to clutch the arms of his chair with all his force, thereby draining off as much energy as possible for the purposes of rigidity and clutching. No energy will then be left, and no motor pathways available with which to function pain. The other method is for the patient voluntarily to sustain muscular flabbiness and collapse, so that no harmful stimulus can rouse any of his muscles to function those tensions and defensive movements that are required for the pain response. We may also get a hint for applied psychology from the fact that the latent period of pain is very long. For of two stimulations given at the same time, one of them painful and the other some strong auditory or visual stimulation, it is more than likely that the pain stimulation will get to the spinal cord later than the other, and will find no motor pathway open. Consequently no pain will be felt. Parents and nurses make use of this fact in dealing with young children who fall down and hurt themselves. They pick up the child and distract it as much as possible by agreeable stimulations which occupy all the available motor outlets and thus prevent the feeling of pain.

It is customary to contrast pain with pleasure, but it must be borne in mind that pleasure is not a sensation. It is rather a quality that may attach

to any sensation, even to that of pain. Nevertheless, it is no accident that pain and pleasure are regarded as correlative. For just as pain normally signifies some disaster to the body, so pleasure normally signifies that the whole kinetic system is expending energy at a rate and in a manner that are well within its capacity to maintain.

CHAPTER XIII

THE SENSE OF MOTION AND THE TOUCH BLENDS

WHENEVER we see, hear, taste, smell, or have any other sensation, a nervous impulse actuates some muscle or gland, thus transforming electrical energy into either chemical energy or the energy of heat and motion. This is a universal law of mental activity which has already been illustrated in several cases. The term "motor response" has been used to refer to the final stage of nervous action, namely, the effect of the motor nerve upon a gland or a muscle. In this chapter we are to consider a very important kind of sensations, those caused by the movement of the muscles themselves.

A distinction is to be made, however, between motor response in general and those particular movements of which we become conscious. For example, while during hunger the stomach is undergoing violent contractions, and although these contractions are muscular movements, yet the only thing we feel is *hunger.* We cannot feel the separate contractions of the stomach, nor are we aware of their velocity and extent—all we are conscious of are the hunger pangs. Again, in the response to cold (goose flesh), the separate contractions of the tiny pili erectores muscles are not felt as such—all we get is the shiver of cold. These two cases are excellent examples of the transformation of the common energies of nature into

the special energies of mind. Likewise, in the case of many other sensations, there is no consciousness whatever of the motor response. Where, then, does the sense of movement come into play? The answer is: That we feel movement *as such* only where pairs of voluntary muscles can play against each other, that is, in all such muscles as those of the leg, arm, hip, neck, jaw, throat, face, eye, tongue, and so forth. The stomach muscles are not voluntary, neither are the *pili erectores*, and hence we cannot feel their movements.

The term *kinæsthetic*, or "movement perceiving," has been given to all sensations derived from those parts of our bodies which are actuated by pairs of voluntary muscles. It is not, however, from the muscles alone that kĭnæsthetic sensations are derived, but from the tendons and joints as well. Let us quote an analysis of these various kinds of sensations:

"First, we have from the muscles the sensation of physical fatigue. If the skin over a muscle is rendered anæsthetic, and the muscle is thrown into forced contraction by an electric current, we have, to begin with, a dull dead pressure; as time goes on, or if the strength of the current is increased, this pressure becomes dragging, the sensation of fatigue; and finally it becomes sore and achy, and passes over into dull pain. From the tendons we get a sensation which, when we are actively pushing or pulling, we call effort, and when we are passively holding or resisting, we call strain; it, too, passes over into pain. Lastly, from the joints we have a pressure: something like the pressure you feel if you smear the right forefinger with vaseline, and turn it in the loosely closed left hand. Take a piece of elastic be-

tween the forefingers and thumbs; pull it out, and then relax it; at the moment of relaxation there is a pressure in the finger joints, which is the specific joint-sensation.

"Investigation has shown that the sensations come from organs in the muscles and tendons. In the tissue of muscles and tendons are sense organs not unlike some of the organs found in the skin. When the muscle is contracted the cells of the muscle become shorter and thicker. This change exerts pressure upon and stimulates the sensory ends between the muscle cells. For example, whenever the arm is moved, there is a contraction in one set of muscles and a relaxation in the opposing set. In one set of muscles the sense organs will be compressed, in the other set the pressure will be relaxed. Each movement and each position has a complex of increasing and decreasing stimulations which is characteristic of that movement in quality and intensity. Strains and weights when the arm is not moved reveal themselves in similar pressure exerted upon the sense organ of the tendons in addition to that upon the muscle organs. *It is by these organs that we become aware of the fundamental properties of the physical world—of motion, of energy, and of mass.*"

From the foregoing it is plain that the kinæsthetic sensations are highly important in acquainting us with the world of physical objects. For example, when we say that a trunk is heavier than a suit case, or a yard longer than a foot, or that a golf ball is speedier than a croquet ball, the meaning of these expressions finally reduces to the way *it feels to lift, to stretch the hands apart, and to throw or strike,* in short, to some form of kinæsthetic sensation. The more skilled we become in any sport or profession,

the finer and finer do our discriminations become. The bungler and the expert, the novice and the professional differ in just this particular form of development.

The term "static sense" refers to our feeling that the whole body is being moved up or down, or that our balance is being maintained or lost. The organs by which these sensations are registered are located in the internal ear in the neighborhood of the cochlea. They are the semicircular canals and the utricule and saccule. The semicircular canals are three in number, set at right angles to each other in the three planes of space. The insides of these canals are lined with fine hairs. When the liquid in the canals is disturbed by the motion of the body, the hairs are moved, and they in turn excite the nerves connected with them. The impulses thus started are carried to the cerebellum, and there transmitted to motor nerves that control the movements of the body, and movements are then made on the basis of kinæsthetic sensations which adjust the members to some new position or restore the body to its upright position again. The organs in the utricule and saccule perform a similar function with respect to the up-and-down motions of the body as a whole. "It is, perhaps, a question whether the static sense is a real sense, for we become aware of its action only indirectly through the movements it induces, or, when the excitation is more intense, by the disturbances of the alimentary tract that give rise to the sensation of giddiness." These disturbances can be readily experienced in riding in a fast elevator. The viscera are less rigid than the bones, and so, when the elevator quickly drops, the viscera are, so to speak, left behind, and they never really catch up with the rest of the body

until the elevator halts. It is the unusual pressures of the viscera produced by such an experience that factor in sea and train sickness.

Since the kinæsthetic sensations are connected with the voluntary muscles of the body, the relation between kinæsthesis and the kinetic system is a very intimate one. This can be plainly observed when we lose our balance and struggle to regain it. The whole energy of the body seems to be poured out at once for the purpose of restoring our balance, while at the same time many of the vital organs are actuated to a high degree. The blood rushes to the face, the breathing is accelerated, and, if we could see all that is going on within us, it would be observed that there is hardly one important organ of the whole body which does not work faster to develop energy that may be put at the disposal of the muscles to bring about a return to normal equilibrium.

Kinæsthetic sensations also appear with many other sensations. The smell of ammonia that is accompanied by pain is also accompanied by kinæsthetic tensions about the eyes and nose. Likewise, bitter tastes bring with them peculiarly marked sensations of movement about the mouth and throat. Indeed, there is scarcely any food that we eat which does not give a peculiar movement quality which assists us in recognizing it. The crust of pie is practically without taste, and yet what precise movement sensations we get from crushing it in our mouths! It is the same way with a thousand other articles of food which a person blindfolded and with his nose stopped might easily recognize from the combined sensations of taste, pressure, temperature, and movement.

This brings us to the touch blends, called in popu-

lar speech hard and soft, blunt and sharp, rough and smooth, oily, clammy, sticky, and so on. In all of these complex sensations there is an element of pressure together with some kind of motion or resistance. For example, hard and soft are words which refer to the resistance of the object to impacts, and these impacts are felt at the joints. Rough differs from smooth principally in the interruption of movement involved. In passing over a rough surface, the finger literally jumps from excrescence to excrescence, and this broken movement affects the sense organs in the articular surfaces. All the other touch blends are similarly made up of dermal and kinæsthetic sensations. "Wetness, for instance, proves on analysis to be a complex of pressure and temperature; it is possible, when the observer does not know the nature of the stimulus, to arouse the feel of wet from perfectly dry things, such as powder, or cotton wool, or bits of metal; and it is possible to wet the observer's hand with water and yet to arouse the feel only of a dry pressure or a dry warmth or cold."

CHAPTER XIV

EMOTION

THE emotions are the most vivid and profound experiences of all our conscious life. No other form of mental activity involves so much of the body or has so far-reaching an effect upon us. Indeed, every emotion may be regarded as a crisis in our physical being, as well as in our social and intellectual nature. It is our emotional life that largely conditions our health, and it is our passions and affections that determine both how many friends we shall make and keep, as well as how clearly and resourcefully we shall think.

Our language is rich in words and phrases which illustrate how potent the effects of emotion are. Fear, anger, and rage; love, ecstasy, and compassion; inspiration, earnestness, and enthusiasm; "the passion for wealth," "the quiver of excitement," and "the pathos of untimely death" are only a few of the terms which man has devised for the expression of his numerous and varied emotions. Sometimes even language fails to give adequate vent to our emotional life, as is witnessed by such phrases as "unutterable grief," "inexpressible devotion," and "speechless rage." Emotions are the permanent pattern in the whole fabric of human relations. Even the hard-headed business man who is supposed to be free from all passion while in his office, none the less manifests just as much disappointment, distrust, anxiety, un-

certainty, and worry as does the naughty truant boy who faces reproach and the paddle on his way home. In short, the Stoic ideal of "the passionless sage" is impossible of attainment, for the most outwardly calm and apparently logical mind fears and hopes for his arguments, and feels alternate joy and grief at their acceptance or rejection by his listeners.

It takes only a moment's thought to realize how large a part emotions have played in history, literature, and religion. The ambitious conquests of kings, the stubborn revolts of downtrodden people, the assassination of hated tyrants, and the martyrdom of patriots and reformers are one and all primarily emotional phenomena. Without emotion literature would be as unentertaining as the multiplication table. The hero as well as the villain of the story attract us chiefly because we feel every pang and ambition which they themselves undergo. An emotionless religion is a contradiction in terms. Even the more intellectual and enlightened creeds speak some form of earnest hope, while those believers to whom fear is an inessential part of their religion are still anxious at times lest the benefits won by intelligence should be dissipated by ignorance.

Important as emotion always has been, little scientific insight into its nature was gained until comparatively few years ago. Nevertheless, even the ancients recognized the importance of the bodily disturbances that always accompany emotions. The Greek philosopher Plato speaks of the baser passions of lust and intemperance having their seat in the abdomen, and the passions of courage and cowardice having their seat in the breast.

Our words "hearty," "heartfelt," "heartstring," and the like are all descriptive of the organic sensa-

tion in emotion. "The psalms abound in phrases that suggest the same idea; we speak to-day of the *heart* coming up to the mouth, or dropping to the boots. So we read in the Old Testament that 'Joseph's *bowels* yearned upon his brother,' and in the New Testament of 'bowels of compassion'; and the inner stir that the writers have in mind is familiar to everybody."

Paradoxical as it may sound, it was not until men turned from the description of their feelings to an analysis of the outward expression during emotion that anything was found out concerning the psychology and physiology of the emotional life. Darwin's book, "The *Expression* of Emotion in Man and Animals," marks the beginning of the new epoch. Darwin gives the following description of fear and terror:

"Fear is often preceded by astonishment, and is so far akin to it that both lead to the senses of sight and hearing being instantly aroused. In both cases the eyes and mouth are widely opened, and the eyebrows raised. The frightened man at first stands like a statue motionless and breathless, or crouches down as if instinctively to escape observation. The heart beats quickly and violently so that it palpitates or knocks against the ribs. . . . That the skin is much affected under the sense of great fear, we see in the marvelous and inexplicable manner in which perspiration immediately exudes from it. This exudation is all the more remarkable, as the surface is then cold, and hence the term of cold sweat; whereas the sudorific glands are properly excited into action only when the surface is heated. The hairs also on the skin stand erect; and the superficial muscles shiver. In connection with the disturbed action of the heart,

the breathing is hurried. The salivary glands act imperfectly; the mouth becomes dry, and is often opened and shut. I have also noticed that under slight fear there is a strong tendency to yawn. One of the best-marked symptoms is the trembling of all the muscles of the body, and this is often first seen in the lips. From this cause, and from the dryness of the mouth, the voice becomes husky and indistinct or may altogether fail.

"As fear increases into agony of terror we behold, as under all violent emotions, diversified results. The heart beats wildly, or may fail to act, and faintness ensue; there is a deathlike pallor; the breathing is labored; the wings of the nostrils are widely dilated; the uncovered and protruding eyeballs are fixed on the object of terror, or they may roll restlessly from side to side. The pupils are said to be enormously dilated. All the muscles of the body may become rigid or may be thrown into convulsive movements. The hands are alternately clenched and opened, often with a twitching movement. The arms may be protruded, as if to avert some dreadful danger, or may be thrown widely over the head. In other cases there is a sudden and uncontrollable tendency to headlong flight; and so strong is this that the boldest soldiers may be seized with a sudden panic. As fear rises to an extreme pitch the dreadful scream of terror is heard. Great beads of sweat stand on the skin. All the muscles of the body are relaxed. Utter prostration soon follows, and the mental powers fail. The intestines are affected. The sphincter muscles cease to act and no longer contain the contents of the body."

Darwin regarded the emotions as inherited tendencies which had once been of great service to pre-

serve the species in its struggle for existence in a hostile and unpredictable environment. He remarks further: "Men, during numberless generations, have endeavored to escape from their enemies or danger by headlong flight, or by violently struggling with them; and such great exertions will have caused the heart to beat rapidly, the breathing to be hurried, the chest to heave, and the nostrils to be dilated. As these exertions have often been prolonged to the last extremity, the final result will have been utter prostration, pallor, perspiration, trembling of all the muscles, or their complete relaxation. And now, whenever the emotion of fear is strongly felt, though it may not lead to any exertion, the same results tend to reappear through the force of inheritance and association."

Emotions, then, originating as instinctive response, have become *serviceable associated habits*. Even to-day, for reasons we know not, "We all jump when we are startled, and wince when we are threatened; and the jump and wince of man are weakened survivals of the frightened animal's leap out of danger, and of its cowering self-effacement in presence of a stronger enemy. The face of scorn lays bare the canine teeth, as if for actual attack; the sneer of man is but a weakened survival of the snarl by which our stronger-jawed ancestors unfleshed their teeth for the combat."

How, now, shall we define emotions? In the first place, emotion is, like sensation, a response to stimulation. But the stimulus to emotion is always some object or situation that has a meaning for our whole mental and physical being. It concerns our entire life and mind. Secondly, emotions usually rise very soon to their maximum excitement, and reverberate

for a long time. Again, emotions are huge masses of feeling which are centered about the vital organs. Moreover, many emotional reactions are so violent and thoroughgoing as to involve an entire change of personality. This is evident by the acts which angry and frightened people perform, for which they often later apologize by saying, "I completely forgot myself."

Why are emotional reactions so violent and thoroughgoing? One reason is found in the nature of man's physical and chemical constitution. The body of man is very highly and very delicately organized, more delicately, indeed, than we might at first imagine. For, notwithstanding the hardships which man endures, the ghastly wounds from which he recovers, and the malignant diseases to which he becomes immune, the human body is always in a state of unstable chemical equilibrium. Vast breaking-down and building-up processes are always going on in every part of our bodies, and it takes but a slight disturbance in any of our functions to wreck the whole organism. Now the emotions are reactions to the most significant stimuli in the environment, and the violence of emotional response merely indicates how unstable our chemical nature really is. Emotions, then, are the index of the fundamental instability of all the vital and mental processes.

Another reason why emotions are so sudden and so violent is to be found in the speed with which the sympathetic nervous system functions. The *sympathetic* or *autonomic* nervous system is a special set of motor fibers proceeding from the spinal cord to the various organs of the viscera and to the skin. Whenever a very strong stimulation is received by

a sense organ, and especially a stimulation that means something for the safety of the individual, the autonomic system of motor fibers throws all the glands and organs of the viscera into heightened activity. This indeed is why we feel emotional disturbances in the region of the heart, the stomach, and the other viscera, and this is also why the kidneys and intestines act now with an unusual freedom, and again with a distressing sluggishness during or following emotional excitement.

Nothing so much as emotion illustrates the truth of our previous observation that mind is the greatest "going concern" of the whole body. For if we consider how many bodily functions are employed to produce such a condition as anger, terror, fear, or rage, it will be at once clear that all but the bones are contributing their share of the excitement. Emotion, then, is the most elaborate form of activity of which the kinetic system is capable; it is the most intense display of muscular and glandular response that we manifest.

Indeed, strong emotion produces exactly the same effects as does bodily fatigue. In regard to this similarity Dr. Crile writes: "Clinically we know that extreme muscular tension, increased heartbeat, and respiration, profuse perspiration, staring eyes, dilated nostrils, pallor and trembling of the limbs are as characteristic of fatigue and exhaustion from emotion as they are of fatigue and exhaustion from muscular exertion.

"The expression and attitude of the exhausted Marathon runner differ little from those of individuals overcome by terror or grief. Were only the faces of these persons seen, it would be difficult to determine whether they were making extreme

physical exertion, experiencing pain, or under the domination of anger or hate. There is little . . . to indicate that in one case the exhaustion is 'physical' and in the other 'mental'."

Wasteful and prodigal as some emotions may be, the theory is sound that they all originated in an instinctive tendency to mobilize all the available forces of the body for some self-preservative action. Dr. Crile remarks on this point as follows: "Fear is experienced only by animals which depend for self-defense and species preservation upon a swift locomotor reaction. The skunk, for example, whose chief means of protection is its odor; the porcupine, defended by its quills; the snake which repels its enemies by its venom; the turtle which is securely incased in its shell; the lion and the elephants secure in their superior strength—exhibit little if any fear. On the other hand, the rabbit, the bird, the deer, the horse, the antelope, the monkey, and man—species which have ever had to struggle for existence against stronger or swifter enemies—these are the animals which preeminently exhibit fear and an irrepressible desire to flee from danger."

The mobilization of the body's energies is accomplished in the following manner. In the first place, the heartbeat is accelerated. This serves three purposes: (1) It warms up the body and thereby prepares it to perform greater feats than would be possible without this "running start." Violent emotion is thus a form of *invisible exercise.* (2) It enables the blood to supply more than a normal amount of glycogen fuel to the muscles. Glycogen is a substance fabricated and stored by the liver, and is fed to the muscles by the blood stream in proportion to the demands made upon them for work to be per-

formed. (3) The quickened blood stream serves also the purpose of carrying off the waste products of violent muscular activity as quickly as possible. All this action of the heart and of the liver is regulated by the autonomic nervous system. In addition, there is a redistribution of blood in the body during strong emotion. The stomach and intestines are supplied with less, while the external muscles are supplied with more.

Moreover, a substance called *adrenalin*, and manufactured by two little glands called the suprarenal capsules, located above the kidneys, is produced in greater amounts during an emotional strain than at any other time. The function of adrenalin is twofold: (1) It shortens the clotting time of the blood, and (2) it increases one's endurance during violent exertion.

In his "The Nervous System and Its Conservation," Dr. Percy Stiles writes as follows concerning the emotional state:

"In times of marked excitement the adrenal bodies are aroused to unusual activity and discharge their powerful product, adrenalin, into the circulation at a more rapid rate than normal. The demonstration and the interpretation of this fact we owe to Cannon. He was able to show by a delicate test that adrenalin makes its appearance in the blood of the cat when the animal has been agitated by the sight of a dog. Additional experiments by workers in the same laboratory have shown that adrenalin is capable of delaying the onset of muscular fatigue. This is accomplished partly, though not wholly, by its acting as an antidote to the fatigue substances at the end-plates. Under the same conditions which cause the discharge of adrenalin there is likely to be a notable

rise in the sugar of the blood above the usual small percentage.

"The rise of the sugar may be sufficiently marked to cause some of it to pass into the urine. This feature of the emotional state has been noticed in human beings. Cannon found that such an escape of sugar occurred in most of the members of the Harvard football squad at the time of the game with Yale in 1913. This was true of the substitutes who had merely expected to be called in as well as of the active players. Moreover, the same "emotional glycosuria" was found to be common among the spectators. It is probably a rather frequent reaction; possibly the excitement of being examined for life insurance may sometimes suffice to cause it and to mislead the physician who detects sugar in the urine. In all cases it is the glycogen or animal starch in the liver which has been transformed to furnish the sugar, and it is believed that the change is brought about by the influence of adrenalin in the blood.

"Cannon has shown great insight in his explanation of these phenomena of emotion. The fundamental fact is that emotions are experienced by the lower animals and by primitive men at moments when vigorous action is to follow. Rage is the prelude to conflict. Fear will be followed by flight. Sexual passion will eventuate in sexual aggression. The mobilization of sugar appears to anticipate a demand for fuel on the part of the skeletal muscles. The extra adrenalin at the same time promotes endurance.

"Very recently Cannon and his coworkers have demonstrated another and a curious change in the blood after an emotional crisis. This is a distinct reduction in the time needed for coagulation. The clot-

ting of the blood is a defensive reaction tending to check hemorrhage and, in case of wounds, to increase the chance of survival. Cannon suggests that emotion is experienced when wounds are imminent, and so a purposive character can be discerned in this physical change as well as in the others."

From all this it is seen just how elaborate a transformation of energy is involved in the stronger emotions. Briefly, they *"mean business."* Rage, anger, hatred, intense sexual desire, and the other violent passions prepare us for the most energetic action of which we are capable.

In the course of civilization, however, it has been found that the action to which raw emotional excitement prompts has not always been the most profitable in the end. For even though it is natural for rage to incite us to demolish the object of our hate, yet such demolition oftener than not yields no profitable return for the future. It does not even bring that immediate satisfaction which seemed to be promised at the moment when the glycogen and adrenalin were being lavishly poured into the blood stream. And by the same trial and error method by which emotional riots were found unprofitable, a device was hit upon by which they could be diverted into safer channels. For it is readily understood that since all emotional excitement leads to muscular action, any control of muscular action will result in cooling the emotion.

Herein lies the value of deliberation, of "counting ten when angry," and of finding some "moral substitute for war." Herein lies also the value for spectators of a great athletic contest, since the crowd at a baseball game, for instance, by giving full vent to their feelings, are thereby enabled safely to clean

themselves out of all the emotional excitement which they have accumulated during the day.

The applied psychology of emotion has other relationships to everyday life. "The temperature of a patient will frequently rise a degree or more as the result of the visit of a tactless friend who perhaps has exaggerated the danger of the illness or has given vehement expression to her grief. There is a traditional Sunday rise of temperature in hospital wards, where additional visitors are allowed on that day, in spite of the fact that the visitor has brought no additional infection and that the patient has made no muscular exertion. In a ward containing fifteen children there was an average increase in temperature of one and one-eighth degrees as the result of a Fourth-of-July celebration."

We must not conclude, however, that the suppression of emotion, which has sometimes been put forth as a worthy human ideal, is psychologically sound. Stoic and Puritan are alike to be condemned on these grounds. Indeed, the stifling of emotion and the lack of adequate vents to its expression are two of the most potent causes of both mental and physical diseases. Dr. Stiles writes on this very point as follows:

"Specialists are now laying all possible stress on the connection between nervous disorders and the suppressed or unsatisfied tendencies which are believed to work harm during long periods of latency. The curbing of a wish, when this means not only the check but the annihilation of desire, is a noble exercise of inhibition. But the denial of expression simultaneously with the continued entertainment of the wish is exceedingly hurtful. The frequent experience of emotions which do not secure any motor out-

let is also abnormal. Anger may not lead to fighting, nor even to scolding, but it may be turned into a motive for vigorous action. The emotion of sympathy is one which we readily recognize as peculiarly exhausting to bear when it cannot be translated into acts. . . . Long ago James made much of the idea that every emotion experienced should become a motive for conduct. If it cannot be so applied, its repetition should, so far as possible, be avoided. This teaching now appears to have much more biologic truth in its favor than it seemed to have when first published. If the primitive expression is out of the question, we may still be ingenious enough to find a harmless or even a profitable substitute."

Still more pointed advice with regard to the unwise suppression of desire is contained in these words of Dr. Crile:

"Often, before any one of the more serious diseases resulting from excessive driving of the mechanism is apparent, a warning may be discerned in the onset of some lesser disturbance, such as chronic dyspepsia, auto-intoxication, disturbances of the skin, the teeth, and the hair. The increased amount of unused secretions and of by-products of activity tax all the organs of elimination, including the skin. It is not surprising that the skin of many highly emotional but 'intelligent' persons in whom we presume control and repression, should exhibit a stained and sallow appearance, should become odorous and oily, or cold, moist, and covered with unsightly blotches and pimples. The skin of virtuous girls, subjected to the emotional strain of a long engagement, often presents such an appearance. The transformation that takes place after marriage may be striking. Indigestion disappears; the appetite returns, metabo-

lism increases; the cold, clammy, sticky, yellowish, pimply skin is replaced by a soft, pink, warm, velvety covering.

"Dentists affirm that under continued strong emotion the character of the saliva changes, pyorrhea tends to develop, and teeth rapidly decay. That emotional strain may cause the hair to turn gray prematurely and to fall out is a common tradition, not unsupported by facts."

Now we can see that it is no accident that emotions bulk so large in the experience of every individual. They are, indeed, the permanent pattern of his mental fabric. Health, intellect, ambition, peace of mind, and a hundred other important conditions of life all depend upon the emotional nature for their existence and success. The use and abuse of emotion, and its redirection and control are large enough topics to occupy many more pages than are allowed in this book. In fact, it would be easily possible to build up a whole psychology on the emotions, relegating to second place all other mental phenomena, without doing any injustice to the facts of the science. The recent advance in abnormal psychology, and especially the work of the Freudian school, is an example of such a system, whose central theme is the baleful results following from the stifling of emotion without giving it a proper outlet. All this, however, we must omit, and pass on to other matters.

CHAPTER XV

THE SENTIMENTS

THE word "sentiment" has a much narrower meaning in popular speech than it has in psychology. Its meaning in popular speech more often than not implies something tender-minded, if not, indeed, something sharply contrasted with "logical" or "matter-of-fact." So much is this the rule, that if you ventured to praise a business man for maintaining a *good sentiment* toward his customers and his employees, he might be entirely at a loss to know just what you meant. He might even flatly deny that there was any sentiment whatever attaching to his business relationships. Of course, we do now and then hear some one say that "he entertains laudable sentiments toward certain people," but such an expression is used only on special occasions. All in all, the word sentiment is confounded with the word "sentimental," which, when applied to a human being, means ultra-impressionable, inconstant, highly romantic, and unbusinesslike. The hard-headed business man says, "Sentiment is for women and poets; I will have none of it."

The word sentiment deserves no such decline in reputation, and it is part of the function of psychology to restore it to its proper place in the language. For as soon as we discover what it really means, we shall have to admit that many a hard-headed business man succeeds only because there are

so many and strong sentiments binding himself and his customers together. For example, if we ask ourselves why we trade at this grocery, shoe store, bank, or restaurant rather than at that one; or why we spend our summer vacation in this valley rather than on that hill; or even why we vote for this candidate or party rather than for the other, the answer nine times out of ten will very likely be, "because we get along well together," or "because they treat me well," or simply "because I like it." And whenever a man uses such expressions, he is displaying *sentiment,* whether he knows it or not.

Now, then, what is this thing called sentiment? It is simply a steady and continuous, but mildly emotional, tone which we have accumulated through our pleasant or unpleasant dealings with people, and which now unconsciously and automatically molds our attitude toward them. Strictly speaking, sentiment means any kind of attitude to which attaches pleasant or unpleasant feelings, mild and refined though they be. "I prefer" usually hints at a sentiment tinged with pleasure, while "I don't like it" hints at the reverse. We also reveal the nature and strength of our sentiments when we say, "We take an interest" in this or that feature of the environment. And since in the background of our minds there are dozens and dozens of such interests, each one waiting for its chance to dominate our actions and sense organs, sentiment, far from being a fugitive or shallow kind of mentality, is the dominant tone of our mental life. For, since every sentiment has an emotional basis, sentiment is a function of the kinetic system, which system, as we have already shown, comprises all the motors and dynamos of the body.

A typical sentiment possesses the following feature: (1) It is a subconscious or unconscious tendency to action; (2) which, when given full rein, is accompanied by some emotion, and (3) may, under different circumstances, arouse different or even opposite emotions. Let us analyze, for example, the sentiment called *patriotism*. This particular sentiment is a subconscious or unconscious tendency to act in behalf of one's country. During times of peace it is dormant, except perhaps on holidays, when flags and oratory bring it to the surface of our minds. On such occasions, as well as during the threat or prosecution of war, the sentiment becomes vigorously emotionalized. Every good patriot is then called upon not only to *love* his country, but to *hate* its enemies. At this stage the sentiment has turned into highly emotionalized action, and all the forces of body and mind are mobilized in its behalf.

Though all sentiments are normally subconscious or unconscious tendencies, they must not be understood on that account to be instinctive. Every sentiment, whether it be patriotism, loyalty of one's employer, or fidelity to an ideal, is the result of education, even though such education be unconscious. For since, as we have said before, every stimulus educates, so we may say now that every emotionalized reaction we make helps to build up sentiments in our subconscious mind. Sentiments are complex. In every one of them we may detect several simple emotions. Patriotism, for example, involves among other things not only a love for one's country but at times a hatred of its enemies. All other sentiments are similarly compounded, some of two, others of three, and still others of more than three simple emotions.

Let us first enumerate the simpler or primary emotions, and then see how they combine to make the sentiments. The simpler emotions have already been mentioned at the end of the chapter dealing with Instinct. They are:

1. Fear, the emotion accompanying flight from a dangerous object.

2. Disgust, attendant upon repulsion.

3. Wonder, accompanying curiosity.

4. Dejection or Negative Self-Feeling, accompanying self-abasement.

5. Elation or Positive Self-Feeling, accompanying self-assertion.

6. Anger, accompanying pugnacity.

7. The Tender Emotion, felt by parents toward their offspring.

Of these seven primary or simple emotions fear, disgust, and negative self-feeling are withdrawing reactions, while the remainder—wonder, positive self-feeling, anger, and the tender emotion—are outgoing reactions.

The simplest combination of these emotions is in the sentiment called *admiration*. This, upon analysis, turns out to be composed of wonder, with a slight admixture of negative self-feeling. Since this sentiment implies a considerable degree of mental development, it is not felt by either animals or very young children. Admiration seems to involve memory and comparison, for we admire only those things which transcend our previous experiences. "We do not simply proceed to examine the admired object as we should one that provokes merely our curiosity or wonder. We approach it slowly, with a certain hesitation; we are humbled by its presence, and, in the case of a person whom we intensely admire, we

become shy, like a child in the presence of an adult stranger; we have the impulse to shrink together, to be still, and to avoid attracting his attention; that is to say, the instinct of submission, of self-abasement, is excited, with its corresponding emotion of negative self-feeling, by the perception that we are in the presence of a superior power, something greater than ourselves."

The sentiment of *awe* is a combination of admiration and fear. Such a sentiment is normally aroused by some stupendous event or scene, such as a magnificent electric storm or a tremendous waterfall. Noises are said to arouse it sooner than any other sensory stimuli. "Awe is of many shades, ranging from that in which admiration is but slightly tinged with fear to that in which fear is but slightly tinged with admiration."

The sentiment of gratitude is a mixture of the tender emotion and negative self-feeling. Our common expression for the tender emotion is simply *affection*. "The act that is to inspire gratitude must make us aware, not only of the kindly feeling, the tender emotion, of the other toward us; it must also make us aware of his power, we must see that he is able to do for us something that we cannot do for ourselves."

When awe becomes blended with gratitude, we experience the sentiment called *reverence*. "Reverence is the religious motion *par excellence;* few merely human powers are capable of exciting reverence, this blend of wonder, fear, gratitude, and negative self-feeling." "Let us imagine ourselves standing before a great Gothic cathedral whose delicate and beautiful stonework is crumbling to dust. We shall probably feel admiration for it, and the spec-

tacle of its decay, or of its delicate and perishable nature, awakens directly our tender emotion and protective impulse; i. e., we experience a tender admiration, a complex emotion for which we have no special name. Now let us imagine ourselves entering the cathedral, passing between vast columns of stone where the dim mysterious light is lost in dark recesses and where reign a stillness and a gloom like that of a great forest; an element of fear is added to our emotion of tender admiration, and this converts it to reverence (or, if our tender emotion does not persist, to awe)."

When a person excites both our anger and disgust, we experience the emotional disturbance called *scorn*. "The two impulses are apt to be very clearly expressed, the shrinking and aversion of disgust, and the impulse of anger to attack, to strike, and to destroy its object." Scorn "is most commonly evoked by the actions of other men, by mean cruelty or underhand opposition to our efforts."

Contempt is a mixture of disgust and positive self-feeling, and may either develop from scorn or be changed into scorn according as anger is added or withdrawn. *Envy* is apparently made up of the negative self-feeling and anger; "the former emotion being evoked by the superior power or position of the object, the latter by the sense that the envied person is excluding us from the enjoyment of the goods or the position that he has or occupies."

Hate, far from being as simple as love (tender emotion, simple affection), is apparently composed of anger, fear, and disgust. This is evidenced by the variety of things we do and the variety of expressions we employ to express our hate. If hate were as simple as anger and fear, it would be accompanied

by a specific motor activity, whereas hate often leaves us speechless and powerless to express ourselves. Besides, hate involves far more visceral turmoil than does any other single emotion or combination of emotions.

The more complex a sentiment is, the more physical and mental powers does it involve, and the longer time does it normally take to satisfy the craving upon which it is ultimately based. This is seen in the sentiment called *reproach,* which seems to be a fusion of anger and the tender emotion. Reproach always seriously implicates two or more persons, and may subtly dominate for a long period of time the minds of all those involved. This sentiment underlies many a person's character, and figures largely in many peoples' love affairs. It is, strange to say, not always an unpleasant sentiment to carry about with one, as many people prefer to cultivate it rather than to get rid of it by frank and cordial dealings with the object of it. Resignation is often nothing more than an intellectualized reproach. Sometimes, also, parental solicitude, especially toward children whose affections they have lost, has this same sentiment for its basis.

Full-blown jealousy is developed only where some sentiment of love or attachment that exists between two persons is interrupted by a third. Jealousy, however, does not arise merely because this third person attempts to draw to himself the love of one of the other two. For even though anger may spring from such an interruption, it requires some painful check to the tender emotion before jealousy results.

"The sentiment of love commonly feeds upon, is sustained by, and demands reciprocation, which, being given, excites in turn a positive self-feeling

or elation that fuses with the tender emotion, adding greatly to its possible character." "And jealousy arises when the object of the sentiment gives to another, or merely is thought to give to another, any part of the regard thus claimed for the self. It is thus an unstable state of emotion, of which the most constant element is the painfully checked positive self-feeling, and which tends to oscillate between two poles, revenge and reproach, according as one or the other is more prominently before consciousness."

The sentiment of *revenge* is not merely anger. "One respect in which the impulse of revenge differs from that of simple anger is its *long persistence* owing to its being developed in connection with a sentiment, generally the self-regarding sentiment. The act that, more certainly than any other, provokes vengeful emotion, is the public insult; which, if not immediately resented, lowers one in the eyes of his fellows. Such an insult calls out one's positive self-feeling, with its impulse to assert oneself and to make good one's value and power in the public eye. It is when immediate satisfaction of the impulse of angry self-assertion is impossible that it gives rise to a painful desire; it is then that the insult rankles in one's breast; and this desire can only be satisfied by an assertion of one's power, by returning an equally greater insult or injury to the offender—by "getting even with him." This painful struggle of positive self-feeling, maintaining one's anger against the offender, is vengeful emotion or the emotion of revenge.

With the sentiments we begin to touch bottom in psychology. For the sentiments are not only the dominant motives in individuals, but they are the moving forces in history as well. The sentiment of

patriotism, for example, contains a large element of revenge, while we need only to spend a half hour with the dramas and novels to convince ourselves that the sentiments we have enumerated are at the basis of all human character. Every notable personage in fiction is the embodiment of a sentiment, and the plot of every play is simply the interaction between human sentiments now brought into sharp conflict and now into harmonious cooperation with one another. What a man calls his religion is simply a great mass of long-trained and deeply interpenetrating sentiments, which center about people, places, and even the words of a book. In fine, the mind of the average man, when he arrives at maturity, is a fixed group of sentiments. His business affairs, his family affairs, his political and social affairs are all regulated, whether he realizes it or not, on the basis of the sentiments to which he has become habituated, and which he has spent his kinetic energy to develop. They dominate him, move him, and direct his every act and thought from then on until the day of his death. Indeed, we might even say, they *are* him, for if we should subtract them from his nature, little that we could call human would be left.

CHAPTER XVI

REACTION TYPES AND REACTION TIMES

BEFORE the days of modern psychology, with its exact methods of measurement and computation, the extent to which individuals differed in their mental processes was little understood. For while Emerson's statement, "There is one mind common to all men," is true, yet the truth of this remark holds only in the large; as soon as two or three persons are subjected to a precise test, it is found that their powers of perception, methods of remembering, adroitness of imagination, and capacity for reasoning are as different as if they belonged to different species. So that, while the science of psychology began with the assumption of a strict uniformity among human minds, no progress was attained in the science until it was recognized in what subtle respects minds differed from one another. However, it is not to be inferred from this that since we do not all think exactly alike, each man's mind is absolutely different from every other one. The truth rather lies between these two statements. For while all minds originate in the same way, yet, owing to physical, social, and physiological influences, they develop variously.

Galen, an eminent physician of the second century A. D., was the first man to suspect the existence of individual differences, and, whether by luck or cun-

ning, he hit upon a method of classifying minds according to temperament. Galen distinguished four classes of temperaments: phlegmatic, sanguine, melancholic, and choleric. "This classification takes account of *the strength and the duration* of the emotive response: the choleric person responds quickly and strongly, the melancholic slowly and strongly, the sanguine quickly and weakly, the phlegmatic slowly and weakly, to the situation which evokes the emotion." And while to the modern psychologist this classification is regarded as insufficient, for the reason that it omits mention of very important mental processes, yet it has taken nearly seventeen hundred years since Galen's time for any developments to be effected along this line. To-day this problem is one of the most fascinating in all psychology, and our modern mental tests are methods whereby we are attempting to feel our way, more or less blindly, toward its solution.

In his classification of minds, Galen laid half the emphasis upon the *speed* of the response, and this factor of speed is still highly important in the determination of individual differences. But to what is this variation in speed due? It was already said in Chapter II that the speed of the nervous impulse in man is 123 meters per second. How, then, can there be quick and slow types, or, to put it in other words, why does one man jump out of the way of a honking automobile, while another man gets run down by it? The answer is that while the speed of the nervous current is 123 meters per second *along continuous nervous pathways,* in both the quick and the slow types, yet there are many chances for interruption between the application of the stimulus and the final

response. Starling enumerates six factors which determine the total reaction time:

1. The time required at the sense organ to convert the stimulus (the honking horn, and the sight of the automobile) into a nervous impulse.

2. The time elapsing between the creation of the nervous impulse and the instant it gets to the spinal cord.

3. The time required for an impulse to break down the resistance between synapses in the brain or spinal cord.

4. The time consumed in the passage of the impulse from the central nervous system down the motor nerve fibers to the muscles.

5. The delay at the end organs of the muscles.

6. The latent period in the muscle itself.

Now if there are extra strong resistances to be overcome at any of these various places along the reflex arc, the reaction will of course be greatly delayed. For example, the sensory receptor organ (eye, ear, skin) may be so exhausted by previous use as to respond only with great difficulty. Again, the muscles may be fatigued, or may even be performing another sort of response at that time. What is more to the point for psychology, however, is that the cord and brain synapses may be closed to all external stimulation, or, as we say in popular speech, the man may be so *preoccupied* as not to notice the automobile bearing down upon him, for even when he does notice it, he may still be unable to marshal sufficient energy with which to jump out of its way.

Here, indeed, we strike bottom again in psychology. For this word "preoccupation" really means the presence of a permanent sentiment, a bias, a "mental set," and this implies that the kinetic sys-

tem has been so trained to certain fixed habits of response, that all outside stimuli, except those which stir up the old sentiment to activity, will have great difficulty to employ any of the body's energy. Mental types are thus largely *variations of sentiment*. In speaking of temperament as a fundamental basis for a classification of minds, Galen showed an almost uncanny insight.

By means of precise experiment, three principal reaction types have been revealed. They are called (1) sensory, (2) motor, and (3) mixed. Professor Titchener thus writes of the discovery of these reaction types:

"The reaction experiment comes to us, of all unlikely things, by the road of astronomy. In the old days, before electrical instruments were invented, astronomers used to time the passage of a star across the meridian of their observatory by means of the *eye-and-ear method*. You can easily imagine the procedure. You have your eye at the ocular of a telescope, the field of which is evenly divided by a number of fine vertical lines. The star enters the field from the right, and crosses to the left; your task is to determine the instant at which it traverses the mid-most vertical line, which corresponds with the meridian. A clock is behind you, beating seconds; and you count these seconds, one, two, three, from a given starting-point. If the star passes the meridian exactly on the beat, well and good; you know the time of its passage; if, as ordinarily happens, it passes somewhere between two beats, then you must estimate the time of passage to the nearest tenth of a second. That is the principle of the eye-and-ear method; you watch and listen, and so make your observation.

"In the year 1796, the astronomer in charge of the Greenwich Observatory found himself obliged to dismiss an otherwise competent assistant, who in the previous year had fallen into the habit of recording his transits some half-seconds too late, and had now increased his error to almost a whole second. This unfortunate man was the originator of what came to be known as the personal difference. For it was found that no two astronomers exactly agreed in their recording of times; every observer differed from every other by a certain average amount. So it became customary to take some highly skilled observer as standard, and to refer other observers to him; and that is the origin of the *personal equation.*"

The unfortunate young astronomer, whose name was Bessel, was what we now call the *sensory type,* that is, he responded too slowly to the stimuli of the bell and the star. He was not sufficiently keyed up to react, so that it took too long (from his employer's point of view) for the nervous and muscular response to be consummated. The sensory type of person is also found in the baseball player who is not quite ready to catch the ball that is coming toward him, albeit he has seen the pitcher throw it, and hears the crack of the bat that announces a long fly in his direction. It is not that his sense organs have ceased to work, but only that his nervous and muscular connections are too sluggish and incoordinated for the particular business that he has to perform. The extreme sensory type is also to be observed in the orchestra player who is always a fraction of a second behind the beat of the conductor's baton, as well as in the pedestrian who is not quick enough to jump out of the way of the vehicle bearing

down upon him. Sometimes the sensory type of a person is called stupid and slow, and may even be judged mentally inferior by those associated with him.

The *motor type* is best seen in the quick, high-strung person who is so thoroughly keyed up to react that he often reacts before the exact nature of the stimulus is perceived. While he usually gets out of the road of the automobile, and the slamming door, and while he usually swats the mosquito before it has gone very far under the cuticle, yet as often as not he makes as bad a mistake in trying to avoid danger as does the sensory type in failing to get out of the way in time. To save the glass of water, he upsets the whole table. On the other hand, the average motor type is a tremendous producer. In the factory and in the pattern shop, selling on the road and hunting in the woods, he sets the pace and determines the standard for his fellows. A man of the motor type is in every way keyed up to perform the appropriate movement, and, provided the stimulus comes as expected, his capacity and accuracy produce a marvellous output of work. The difference between the sensory and the motor type "may be brought out by a homely illustration. When the lights are turned on in the evening, it is not uncommon, even in the best regulated families, for a clothes moth to start up from some corner. You say 'There's a *moth!*' and clap your hands to kill it. But it escapes; and henceforth you do not trouble to identify it; you clap your hands at anything mothlike that flits across the field of vision; you are set or disposed for the movement. So in the two forms of the simple reaction: some observers tend naturally to make sure of the stimulus before they move, and others tend naturally to move, as soon as any stimulus has appeared."

Midway between these two reaction types—sensory and motor—is the *mixed* reaction type. A person of this type responds at a rate intermediate between the speeds of the other two types. But speed is by no means the only differentiation to be considered. For the mixed type is usually developed out of one of the other two, and this change involves the highly significant factors of training, discrimination, education, and deliberation. For a man to change from the extreme motor type to the mixed type is equivalent to his ceasing to be rash and impulsive, and to his developing capabilities far in advance of his natural endowments. He learns to select and to foresee results, and, instead of "dashing off madly in all directions," he now tempers his speed with wisdom. For a man of the slow, sensory type to change to the mixed type involves a similar education, and often results in his acquiring more speed than one might suspect possible for him to attain. For the slowness of the sensory type is often due to the fact that too many stimulations awake impulses at the same time, with the result that no specific activity can get thoroughly motivated. Education toward the mixed type brings in his case the ability to select and to respond to one significant feature of the environment, and consequently increases the speed of the response.

There is an old motto which reads: "Slow, but sure." Modern psychology does not support this motto, for with precise experimentation it has been shown that accuracy is as frequent an accompaniment of actions of the motor type as it is of actions of the sensory type. For quick or impulsive action is not necessarily misdirected action—indeed, as we have already stated, men of the motor type are the

world's pacemakers in actions requiring adroitness and skill. There is also another advantage which people of the motor type possess. It is their ability to recover themselves quickly after an error has been made, and to start fresh without loss of time or ambition. The man of the motor type is also usually sanguine—he believes in his own future and consequently discounts his past failures and his present inabilities. When, therefore, such a man is educated and changed into the mixed reaction type, the final product is on the whole more excellent than that represented by the educated sensory type. For the latter lacks that precious original buoyancy and kinetic velocity which pertain to the motor type of individual, and consequently his resources of energy are never quite so readily mobilized.

Such a classification as this one, accurate as it is, only touches the surface of human nature. For men differ not only as to the speed of their responses, but also as to their powers of attention, of imagination, of reasoning, of remembering, and even of forgetting. These differences, however, we shall leave for discussion in the chapters upon these special topics which are soon to follow.

CHAPTER XVII

THE PERCEPTION OF SPACE

THE meaning of the word "perception" can best be brought out by a simple illustration. If something is held up before your eyes, and all you can see of it is the color, you have only a sensation; but if you say, "It's an orange," or "It's a sheet of paper," you have, on the contrary, a perception. Likewise, if you experience a sharp skin pain, but know not the source of the annoyance, you have again only a sensation, whereas, if you cry out, "A needle is pricking me," or "That mosquito bit me again," you have not only *sensed,* but *perceived.* In other words, perceptions involve "acquaintance with" and "knowledge about" the stimulus which produces the sensation.

Perception is thus equivalent to understanding, or comprehension, or recognition. Indeed, it takes only a little thought to reveal the fact that the adult mind almost never has a pure sensation, since the adult mind tries to *name* everything it experiences.

Even the untutored ancients called the obscure abdominal sensations "yearning of the bowels" in their attempt to *perceive* the cause or meaning of that particular feeling. And when we come down to the fine points of the matter, every *name* whatever that we give to our sensations implies some form of perception. The terms "bright red," "lukewarm,"

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A Test in Hearing. The subject sits with his head turned away from the apparatus. The weight is dropped, and he endeavors to tell the distance it falls by the sound as it hits the block of wood.

THE SPHYGOMANOMETER, OPERATED BY ELECTRICITY. The device measures the blood pressure as affected by emotion. It is the theory that it can be used to detect lying, because of the emotional disturbance the effort to tell an untrue story causes in the subject.

"lemon sour," and the like, being one and all *discriminative*, imply perceptions as well as sensations. And since such naming of the stimulus is an inveterate habit with the adult, pure sensations may be said to be felt only by the newly born infant, who knows neither the name, the source, nor the meaning of his experiences. Perhaps the lower creatures, who have neither language nor a span of life adequate to acquire a knowledge of the relations of things, live in a world of pure sensations.

We may now go one step farther and say that perception not only involves "acquaintance with" and "knowledge about" the stimulus, but is itself a test of these things. Perceptions, then, are of varying degrees of comprehensiveness. For example, while we may all know something about golf, and may realize at the sight of the players on the golf course that they are knocking a little ball around with a little stick, yet how limited is such a perception in comparison with that of the man who comprehends the meaning of the following newspaper report:

"Ray leaned on one at the eighth, the ball striking the road on the fly and bounding part way up the hill. Ouimet and Vardon failed to get on on their seconds, Vardon misjudging the distance considerably. Vardon apparently had an easy four, but once again slipped up on a three or four footer. It was Guilford who won the hole, being on nicely and rimming the cup on his approaching putt. Ray and Ouimet played the hole poorly, taking fives."

The same variations in the breadth of perceptive ability are seen in the comments of those who attend a baseball game, a symphony concert, as well as in the remarks of the purchasing public at stores and

cafés. Indeed, a man's perceptions reveal the breadth and depth of his experiences. To say, "I perceive that . . ." is equivalent to declaring, "This much I know, and no more."

One of our most important mental activities is the perception of space. Our knowledge of near and far, of long and short, of high and low, of deep, wide, and narrow, in brief, of extension and limitation in all directions, is an acquisition essential not only to the development of thinking but to the maintenance of life as well. By means of this knowledge we calculate almost all of our important ventures. The journeys we propose, the steps we take, the putting out of our hands to steady ourselves, the avoidance of ruts and stones in the street, the bringing of food to our mouths, "swatting flies," dressing, bathing, and a thousand other movements we make all involve the perception of the spaces round about us. Were we lacking in this power we might starve to death within easy reach of food, mistaking a foot for a mile. The perception of space has thus not only a value for the astronomer, the architect, the bridge builder, and the dressmaker, but it has also a survival value for the human organism in all of its important dealings with the environment.

The acquisition of the ability to perceive space relations comes by dint of long training. It is not possessed by the newly born, for the baby reaches out with equal confidence for the milk bottle and the moon. Nevertheless, the first hints as to near and far, wide and narrow, etc., come quite early in life. The restless infant squirms about in the crib and soon learns that comfort and his *position* have much to do with one another. In addition, as we have already indicated in Chapter III, the grasping

reflex soon teaches him of larger and smaller, longer and shorter. Moreover, he soon begins to explore his own body, and is said to regard the discovery of his toes as a "great find." All this moving and stretching, pulling and pushing, together with rolling and turning of the head not only relates his various stimulations to each other, but also serves as a means whereby he discriminates between them. Upon rolling his head to the right, he sees one sort of thing, while at the same time he loses sight of the objects on his left. This starts a faint trace of the meaning of *here* and *there* in his mind. Upon looking down at himself, he gets the notion of near, while upon looking up he gets the meaning of *far away*. And so on throughout a long list of looks and gestures, postures, and acrobatic performances, each one of which acquires a meaning for his environment of space. Gradually, also, voices that are faint mean distance, while voices near at hand are signified by their loudness. In this way the child's varied experiences educate him to realize the meaning of distance and dimension long before the words which discriminate between the various distances and dimensions have passed his lips. Indeed, even adults cannot claim any too specific an understanding of the fundamental terms that imply space, as may be readily discovered if you ask an acquaintance to define the words *here, there, high, low, near,* and *far!* He will simply point about him and illustrate rather than define their meaning, and this is equivalent to his confessing that he is still a child when it comes to knowing what space is.

We perceive space by means of only four senses: sight, hearing, kinæsthesis, and touch. Smell, warmth, and cold may give us direction, but all

other senses are entirely spaceless. **Pain, for example**, tells only of location and intensity, since there is no difference between the feelings produced by a round hot object and a square one, or between scratches that are parallel or at right angles to one another.

That the skin contributes a large part to our knowledge of space may be shown in several ways. In the first place, a light touch upon the brow is immediately distinguished from a similar touch on the nose, the chin, or the knee. That is to say, the different parts of our bodies seem each to give a different *quality* of touch sensation, and it is this difference of quality that enables us to recognize the *position* of the stimulus. It feels differently to be touched on the nose than to be touched upon the lobe of the ear, and there is a distinct change in feeling when we are first touched on the heel and afterward on the toe. How is this possible when all the organs of touch are alike? The answer is that the difference in these qualities of touch is due to the different responses we make in each and every case. To be touched means that something external to us, something foreign, something maybe harmful has made contact with us, and this stimulation arouses much more than merely the organs in the skin. The extent of this arousal is not exactly known, but certainly a touch on the ear lobe may be safely conjectured to start an impulse to turn the head in that direction, while a touch on the forehead arouses a tendency to withdraw the head so as to enable the eyes to see what is there. Such latent tendencies may be assumed for every different quality of touch. In other words, the kinetic system is so concerned with what touches our skin that it

immediately starts defensive or offensive movements whenever touch stimulations of this sort are received. And it is the infinite variety of possible muscular coordinations which is responsible for the difference in the feeling of being touched on the ear, the brow, the toe, the heel, the knee, the shoulder blade, and on a thousand other locations on the skin.

The skin gives not only position, but *movement* and *direction* as well. A fly crawling across the face acquaints us at once with the order of his going by stimulating with his feet different touch spots on the skin surface. The fly also gives a notion of *speed* by the rate of change in the quality in the touch sensations he arouses, and an idea of *distance* by the number of touch spots stimulated during his visit.

Here, then, we have five factors which are essential to space perception—position, movement, direction, speed, and distance. But the skin alone gives only what is called in geometry two-dimensional space—space in a plane surface. It is not until we come to the senses of movement, hearing, and vision that we add the third dimension—*distance from the body*—to our knowledge of space.

The skin is often a "shifty witness" of the location of some stimuli which produce touch sensations. Two blunt compass points placed near together on the skin are not always recognized as *two* unless the part touched has previously received special education in this respect. In the untrained person who has not learned to make the finer discriminations between distances on the skin, compass points placed at the following distances apart will be felt as one single touch.

Region of skin	*Distance between points in millimeters*
Tip of tongue	1
Tip of finger	2
Lips (outer surface)	5
Tip of nose	7
Lips (inner surface)	20
Back of hand	32
Forearm and leg	40
Breastbone	45
Back	54
Upper arm and thigh	68

The fact that our kinæsthetic sensations give us a knowledge of movement makes them of paramount importance for the perception of space. For *space means extension in different directions*, and every hint we get of extended things is due to our own ability to move. We even call one set of the voluntary muscles the *extensors*, that is, the muscles which enable the arms and legs to reach out into the environment. But kinæsthetic sensations give us more than just this feeling of extending and retracting the arms and legs. We can also rotate the arms in wide circles, and by making all sorts of complicated gyrations with them explore the space about us. Moreover, the hand can move over the skin surface, across it, and around it in all directions, thereby provoking all manner of skin, joint, tendon, and muscle responses which are coordinated into perceptions of size, length, curvature, and so on. It is by this means that the infant learns the rudiments of space while exploring his own body. The kinæsthetic sensations, then, in giving us all three dimensions of space, are the greatest source of our

ability to discriminate between distances, angles, curvatures, and extents of all sorts.

The sense of hearing contributes to our perception of space by affording us cues whereby we judge both the *distance* of the sound from us and its *position* with respect to our bodies. If the distance between ourselves and a sound is changing, we are often able to judge the rate of this change with considerable accuracy. But in all this a previous knowledge of the source, quality, and intensity of the sound is essential, and in normal individuals this knowledge has been acquired chiefly through the senses of sight and motion. The cues which the ears provide are one and all gradations of intensity, and these must be supplemented at all points by our visual and kinæsthetic experience.

It is easy to show that the ears, unassisted, make many mistakes in judging the distance and position of a sound. If the head is held steadily while an electric buzzer is sounded at various places near by, it is found that, while sounds well to the left and right of the head are judged with an error of only 5 to 10 degrees, all sounds produced directly in front, behind, above, or below the head are curiously mistaken as to their location. The error is sometimes as much as 180 degrees. A sound made exactly in front of the person may be judged to be directly behind him, whereas a sound directly below may be thought to occur directly above him. Several overconfident persons have been known to lose wagers by submitting themselves blindfolded to such a test. The law is that we recognize the position of a sound solely by means of the relative intensity with which it strikes the two ears; hence all sounds that strike the ears with equal force, i. e., those

directly above, below, in front of, and behind the head, are frequently misjudged.

Nevertheless, this law holds only for either pure tones or short noises. For, in the first place, prolonged noises and complex tones set up echoes which furnish cues of their own, and, in the second place, we know by previous visual experience that some sounds are unlikely to occur at certain places. For example, the cracking of a twig in the woods must come either from the ground around us or from the trees above us, and the barking dog cannot be flying through the air. Similarly, while the echoes of a bell may seem to come from a rocky cliff, we know from experience that there are no bells hidden within the stone. But "where the nature of a sound is misinterpreted, the distance is wrongly estimated. The buzzing of a fly very near is occasionally mistaken for some strange, loud noise at a distance, and similar mistakes in judging distance are rather frequent." Sometimes, when the testimony of witnesses in a court room includes judgments of auditory space perception, the lawyer who knows a little psychology can bring the witness to confusion by performing some such simple test as we have previously described.

Professor Pillsbury writes of the space perceptions of the blind: "For the blind the auditory perception of space is much more important than for the seeing individual. Not only are they more accurate in their localizations of sound, but they use sound to obtain an idea of the space in which they are walking, and of the distance of obstacles. The echo of the footsteps varies with the size and shape of the room, and the time between the echo and the original sound increases with the distance of a wall

or other obstacle. Even when the echo is not noticed, it affects the quality of the tone. The blind have learned to connect this quality of the tone with the different distances of objects, and guide their movements accordingly. When the boys in a blind asylum were provided with felt slippers in place of their heavy-soled shoes, they could not avoid obstacles with their usual skill. The footsteps were noiseless, and they were deprived of their most important means of appreciating objects at a distance."

The eyes are the most important of all the sense organs from which we derive our perceptions of space. For not only does the retina of the eye furnish an extended sensory surface on which many stimuli may fall simultaneously, but the eyeballs themselves also move in their sockets and thus become kinæsthetic aids in our perception of movement and extension. Moreover, the two eyes, by focussing on the same point and by combining two different pictures of the same object, furnish us with the most reliable cues for depth or solidity. The popular maxim, "Seeing is believing," is thus based on physiological fact.

However, even the single eye can give us a knowledge of position. In visual terms the word "up" means that a stimulus causes the eye to roll in a certain direction, thereby producing a characteristic kinæsthetic sensation that differs significantly from the sensation felt when the eyeballs roll in the direction we call "down." This difference in kinæsthetic sensations is fundamentally one of greater tension in the eye for "up" than for "down." Moreover, this eyestrain becomes associated with the feeling of the lifted eyelid and the elevated brow. All these kinæsthetic strains become subconsciously

fused to give the final meaning to the word "up," while the fusion of sensations from the muscles which antagonize these movements come eventually to mean "down." Other qualities of eye and eyelid movement come to mean "right" and "left," "diagonally," "across," "under," "on top of," and so on throughout all the list of terms which mean space. The eye, however, does not get educated by itself. From early infancy we touch and fumble what we see, we move it, displace it, and roll it about with our hands, thereby associating movement sensation from the hand and arm with sensations from the eyes. Besides, one of our earliest actions is to turn the head in all directions to bring light to bear upon the fovea (see Chapter III), and so there are finally established kinæsthetic sensations from all the movable parts of our bodies. In the adult it is the sum of these motor responses which give meaning to the various words that imply direction and position in space. But these motor adjustments become so fine and so thoroughly second nature to us that it takes the most careful self-observation to bring them to our notice.

The sum of all this is that *we perceive movement by moving ourselves, or by means of the strain sensations of muscles about to be moved,* even though such movements and strains may not be noticed by us. A very interesting experiment has been devised to demonstrate the truth of this principle. If the arm is laid comfortably on a board that is hung from the ceiling by springs so supple that the slightest pressure will cause the board to be depressed, and if a fine wire lever attached to the end of the board is so pivoted as to make broad excursions at the free end upon every movement of the board, up or down

or from right to left, and if, then, the person submitting to the experiment, being blindfolded, lays his arm upon the board and merely *thinks* "up," "down," "right," "left," and the like, he will unconsciously move the lever in various directions, showing that even the thought of spacial relations is bound up with movements of his arm in space. Were we able to record with equal delicacy and accuracy the behavior of the eyes while we are thinking space relations, their movements would likewise illustrate the same general principle. Indeed, we often get just such hints from the eyes of the people as to where they are looking and what they are thinking about. Coy maidens out walking with their duennas only with difficulty conceal their secret desire to communicate with passers-by.

As we perceive movement, so do we perceive extension, both in one dimension, as in the case of a line, and in two dimensions, as in the case of a surface. In both cases the stimuli arouse either movement itself or strain sensations of movements held in check. The eye has been accurately photographed while lines of various lengths were exposed to view, and in every case the eye was found to roll in the direction indicated by the line. In the case of surfaces, the eye always tends to trace their boundaries. Space perception by the eye is thus accomplished through *imitative movements*. As can be readily comprehended, the eye, by rolling a very short distance in its socket, can perceive a very considerable extent, especially if the point of fixation be far away. For example, it takes no more eye movement to perceive a tree two hundred feet high a mile away than to perceive the length of a match held in the hand. In this respect the eye is like a telescope which

swings only a small fraction of a degree on its pivot to pass over a vigintillion miles of interstellar space.

If the perception of visual space is always accomplished by ocular movement, the question may arise: "How do we perceive such a bit of design as the following cross?" Can our eyes move both up and

down and sideways at the same time? Obviously not. Nevertheless, if you fixate the intersection of the lines, no matter how willfully you try to keep the gaze riveted there, you will find your eyes constantly tempted to move out along some one of the cross-bars to its end, and it will be only with the greatest effort that you will be able to abort all such wayward tendencies in the eyes. What does this mean? It means simply this, that all such straining of the eyes away from the intersection of the lines is the very mechanism of perception by which we comprehend this particular design. In the case of more complex designs, more complicated eyestrains and incipient movements are brought into play, and in such cases we realize once more that only very small efforts on the part of the eyes are required for the comprehension of considerable distances and complexities.

A very handy and precise term for these imitative movements which aid in space perception has recently been coined. This term is *empathy*. *Sympathy* means the tendency to feel with, or to share the emotions and sentiments of, animate beings, while *empathy* means the tendency to imitate any attitude, posture, or design. All sympathy is empathy plus emotional response.

Now space perception is always accomplished by means of empathic responses on the part of our most motile members—the fingers, hands, and arms,

the tongue, the lips, and the eyes. Of all these perhaps the eyes are the most frequently used in pure space perception; certainly their movements are the most various and the most capable of unlimited combinations. Each eye is provided with six muscles, and these muscles are supplied exclusively by three of the twelve cranial nerves. Such an abundant nerve supply is no doubt responsible for the fact that we can use our eyes all day long for all variety of empathic responses without unduly fatiguing them.

In Vernon Lee's little book, "The Beautiful," there occurs an account of the empathic response to features in the landscape which has rightly attracted much attention from those who are soberly interested in the mechanics of mind. Vernon Lee there shows that when we say, for example, "the mountain rises," it is only our eyes and chin and head that are being elevated, the better to view the mass of rock and snow before us. The mountain, to be sure, attained its full height long ago, its solid mass is fixed; we, however, being made not of solid, but of liquid matter, are capable of such variations in response that even the apparent height of the mountain alters with our attitude toward it.

In the same way the traveler, who reported that "just as night was *falling* he perceived that the desert *stretched* many miles farther to the south," was describing precisely what certain parts of his own body were doing at that time. For, while neither do nights "fall" nor deserts "stretch" in the literal sense of the terms, yet darkening skies feel like descending black canopies, and distances yet to be traversed induce prophetic strains in the tendons.

How, now, do we perceive distance or depth, or, as it is sometimes called, the "third dimension"?

Evidently distance cannot depend upon how the retina is stimulated, because a point of light affects the retina in the same way, whether the source be two feet away or as remote as a fixed star. We must accordingly seek for our explanation elsewhere—that is to say, in the response mechanisms of the eyes, and in the cues we derive from our handling of the objects about us. These two classes of factors we may call respectively the physiological and psychological. Let us first enumerate and explain the physiological factors in space perception.

To begin with, the lens of the eye automatically changes its shape for near and far by means of the ciliary muscles and the elastic membrane surrounding the lens. "If one looks at a distant object, the lens is flat and the muscle of accommodation is relaxed; if one looks at a near object, the lens is rounded and the muscle contracted. One may feel the change in strain as one looks from a remote to a near object. This strain of accommodation gives an idea of the distance of the object." Slight strain means remoteness, while increased strain means nearness. It is thus not the retina, but the lens and the ciliary muscle which provide us with the first hint of the third dimension. Moreover, it appears that the lens of the eye has the unique property of being responsive to *distances as such!*

The second physiological factor is called *convergence,* and involves both eyes. The two eyes move as one, that is, they both turn inward at the same time to view objects near at hand, while their axes tend to become more and more parallel when we are looking at objects farther and farther away from us. "This can be seen directly in another's eyes. When he looks at a distant object the white shows about

equally on each side; as he looks at an object only a foot away considerably more white will show on the outside than on the inside of the eyes." Convergence, of course, produces sensations of strain which increase in intensity the more sharply the eyes are converged. But more often than not these kinæsthetic activities are wholly unconscious. In either case, however, they arouse a general motor attitude of *reaching out for* the object, and this attitude the whole kinetic system faithfully develops and maintains.

The third physiological factor is called *double images.* If you hold up your clenched fist, thumb knuckle toward you, about six inches from the nose, and then close alternately the right eye and the left, you will observe not only that one eye sees more of one side and the other eye more of the other side of the fist, but also that the thumb knuckle appears to shift right and left as the eyes are alternately opened and closed. A spot of ink on the thumb knuckle will accentuate this phenomenon. This experiment shows that each eye gets a different picture of the object. Moreover, since the two eyes are situated about two and a quarter inches apart, they together are able to take in a little more than 50 per cent of the surface of any round or cylindrical object, such as a ball or a tree, thereby providing us with ample cues as to its curvature. Since the difference in the two eye pictures decreases directly as the distance of the object from us, this fact furnishes a valuable subconscious cue for our depth perceptions.

Theoretically, all objects in space not fixated should appear double, but our custom is to ignore these double images, that is, to *react as if* this were not the case. This doubling can be shown by a very

simple experiment. If you hold up one index finger about five inches from the nose, and the other index finger a foot away, and if then you fixate the nearer finger, the farther one will appear to double. Contrariwise, if the farther finger is fixated, the nearer one is doubled. More than that, the doubled finger is not altogether easy to locate as regards its distance from the eyes. If another person holds his finger up for you to fixate in this experiment, the aforementioned fact will be more obvious, for you already knew with your own fingers just where they were. If you ask why the fingers appear doubled at all, the answer is that each finger is a stimulus to vision, and consequently is, so to speak, soliciting the eyes to look at it. But it is impossible to look at both fingers at once. The unfixated finger, then, doubles because of the opposed motor tendencies in the eye mechanism. The doubled finger also appears as near the plane of fixation as possible, because the motor activities of convergence and accommodation so dominate the whole kinetic system as to drain off all conscious responses down one final common path —the fixation path.

Employing the principle of double images as illustrated in the last experiment, we are able to make this bird go into this cage:

First get the "far-away look" in your eyes, that is, imagine you are fixating the most distant object possible, and then, while holding the eyes unwaveringly in that posture, bring the picture up to a position about six inches before the face, cage in front of the left eye and bird in front of the right, whereupon the bird will slide into the cage. But at the same time you will observe out of the corner of your eye, as it were, that there is an empty cage on the

left and a homeless bird on the right. Since neither bird nor cage was fixated, they both doubled. The inner images of bird and cage came together, while the outer ones remained widely apart. You can remove these outer images from the field of vision by placing a postal card edgewise to the nose (while

still maintaining the previous fixation), so that it points directly toward the middle of the picture. "The *stereoscope* makes application of this principle of double images to give the appearance of depth to pictures. The stereoscope slide has two photographs taken from slightly different positions. When the two pictures are combined, the result is a series of double images similar to those that would have been produced had the observer been standing where the photographs were taken."

Homemade stereoscopic slides of simple geometrical figures can be made by anybody who will take into consideration the appearance of the fist to either eye in the experiment we recently described. The spot of ink on the thumb knuckle is, when the two eyes are open, the *psychological center* of the fist. With the right eye alone, this center shifts to the

left; with the left eye alone, it shifts to the right. Very well. Let us apply this knowledge to the making of stereoscopic slides. The psychological center of any object is to the left in the right-eye picture, and to the right in the left. Let us now draw stereoscopic pictures of a square pyramid whose apex points directly toward us. Close one eye, and the apex will appear to shift toward the other eye. Now let us draw the two pictures:

STEREOSCOPIC VIEW OF SQUARE PYRAMID WITH APEX TOWARD US

If you do not have a stereoscope handy, combine the two pictures in the same way as you made the bird go into the cage. One may also construct a stereoscopic slide (or stereogram) of a truncated cone whose top is nearer to us than is its base. Remember

STEREOSCOPIC VIEW OF TRUNCATED CONE

that the right eye sees more of the right side and the left eye more of the left side, and consequently, when looked at with one eye, the top of the cone will appear shifted slightly to the opposite side with either eye. Any other simple stereogram may be similarly constructed, such as representation of a stone archway,

a shed, or a row of piles extending into the water, provided it be always remembered in what respects the two eye pictures are different.

The principle of the stereoscope is that by means of suitable prisms two pictures taken from slightly different positions may produce the effect of depth or solidity. The eyes do not need to be forcibly converged on a far-distant horizon, since the prisms throw the pictures into the eyes at the right angle to produce the desired effect. The two pictures are taken at the same time by the stereoscopic camera, whose lenses are placed at about the interocular dis-

STEREOSCOPIC VIEW OF TRUNCATED SQUARE PYRAMID

tance. Conjecture, then, what would be the effect of a stereogram whose pictures were taken at a greater distance apart than the interocular distance. That is to say, if you could see farther around both sides of a tree or a ball, how would it look? The answer is that it would have greater depth, and consequently would appear more solid than ever. This new principle is employed in the range finder used on warships or on battle fields. The range finder contains four mirrors (*a*, *b*, *c*, *d*) so placed that the outer two (*a* and *d*) may receive light from wide distances apart and reflect it into mirrors *b* and *c* which are located in front of the observer's eyes. By this means the left eye behind mirror *b* gets the same impression that it would if it were located at

mirror *a*, while the right eye behind mirror *c* gets the same impression that it would if it were located at mirror *d*. It is as if the interocular distance were tremendously increased. Consequently, all distant objects are viewed with the same ease as if they were very near; their motions are magnified, and their direction or tilt is easily discernible. The advantage of such an improved vision on either land or water in war, to discern the speed, formation, and maneuvers of ships or men is readily comprehended.

PRINCIPLE OF THE RANGE FINDER

Opera glasses and prism binoculars employ this same principle, only to a less degree.

Yet a more daring use is now made of the principle of the stereoscope in war. For it is perfectly in accord with the theory of the stereoscope to infer that the farther apart the pictures are taken, the better defined will be the depth relations of distant objects. This inference has recently been shown to be correct. Two airplane observers a half mile apart both took single pictures of intrenchments miles away, each observer being careful to keep the same common land marks in the exact center of his picture. The result was that when the two pictures

were developed and combined in the stereoscope, every trench, tree, shell hole, and embankment was clearly revealed to view. And not only were the relative heights and depths of far distant objects tremendously exaggerated, but their relative positions with respect to one another were also clearly discriminated.

Not even is the moon too far away to prevent us from making a stereogram of her globe. Two cameras, one at New York and the other at San Francisco, could be employed at the same time to get the widely different eye pictures needed. But, fortunately, no such trouble is necessary. For since the moon always keeps the same face toward us, all we need to do is to take one picture at one hour of the night, and another from exactly the same position of the camera an hour or so later. The two pictures will readily fuse in the stereoscope, and the result will appear like a solid globe on which the dead craters of the moon stand out with remarkable clearness.

Passing now from the physiological factors in space perception, let us turn at once to the psychological factors.

The first of these is called *perspective.* If you look down a railroad track, the rails appear to meet for the reason that the farther away an object is the less of the retina does it stimulate. Hence it is that we always interpret a smaller object to mean a more distant one. Draughtsmen and painters of to-day employ this principle widely. On the other hand, Egyptian art has no perspective at all. It is all in two dimensions. Small and large do not mean far and near, but rather indicate the rank and caste among the persons represented. One point is curious

to note in connection with the phenomena of perspective, which is that while a boy near at hand may appear twice as tall as a man a mile away, we summarily discount this difference in size. The distant man arouses the same general attitude in us that a man near at hand would produce. In this respect the kinetic system appears to respond independently of the amount of retina stimulated.

A second psychological factor is called *parallax*, or the rate of movement of objects in relationship to one another. "If the *usual* rate of motion of an object is known, its *apparent* rate indicates its distance. Far objects seem to move more slowly, near ones more rapidly. A distant railway train seems to crawl across the landscape, while the near one rushes past. As one moves the head with the eyes fixed upon the horizon, near objects are displaced considerably, distant ones very slightly or not at all. If one is looking at a near object and moves the head, objects far from the point of fixation move more, those near it less." Professor Starling asserts that "Even when we are standing still, we are all the time making involuntary movements which cause the development of parallax. This process is probably one of the most important in producing the monocular effect of depth."

Another psychological factor in depth perception is "the *haze* and *changed color* that come with distance. Distant objects are hazy, indistinct, and blue in color, while near objects are clear and have their own colors. The changed color and haze depend upon the amount of air intervening. In a very clear, dry air, estimates of distance are subject to large mistakes on the part of one who comes from a lower altitude and denser atmosphere."

"A fourth very simple sign of relative distance is *superposition.* Objects that hide part of other objects are evidently nearer than the objects covered. Finally, *shadows* furnish a means of estimating the relative distance of parts of the same object. Bright parts of the surface are ordinarily nearer, shaded parts more distant. The interpretation depends largely upon the way the light is falling, but with any illumination lights and shadows give a means of estimating the distance of the parts."

These five psychological factors unite with the three physiological factors to produce our notions of the distance of objects. Sometimes all eight are present at one time, while again only two or three may operate. But in all cases the distance that we feel things to be is the result of various stimulations upon our motor mechanism. Distance means *reaching out toward,* and so the ultimate significance of the third dimension is expressed by the words "How far would I have to go to get there?" From this it can be seen that *we perceive space as much with our hands and legs as we do with our eyes,* since many other muscles than those concerned with the eyes are involved in such widespread motor responses.

The question may naturally arise in some minds, "How accurate are our perceptions of space?" For if all perceptions of extension, movement, position, and depth are based on motor responses, is it not possible that we may often respond too much or too little to the stimulus, and thereby make an erroneous judgment as to the size or distance of an object in space? More than this, is it not often likely that we may be either so eager or so unprepared to respond that the same stimulus may evoke different reactions at different times? The answer is in the

affirmative: we *do* misjudge distances and extensions all the while. Nevertheless, to be conscious of such errors implies that we have some means of measuring the extent of our mistakes, and this fact leads directly to an important law in psychology. It is called Weber's Law, and it is the law of *illusions of magnitude*.

The discovery of this law was accidental. While toying with a pair of blunt compasses, the German physiologist E. H. Weber found to his surprise that only at certain distances on the skin could the points be felt distinctly as two. By following up this cue, Weber discovered the threshold of distance discrimination for various parts of the skin, the figures for which we have already given in the early part of this chapter. But more than this, Weber was prompted to ask how much in error were the rest of our naive judgments of magnitude, for example, our discrimination of weight, of pitch, of odor, of active movement, and the like. The results of experiment showed that for each sense organ there was a fixed percentage of error, and this discovery led to the formulation of the law of illusions of magnitude.

Weber stated this law as follows: "In comparing objects, and observing the distinction between them, we perceive, not the difference between the objects, but the ratio of this difference to the magnitude of the objects compared." This law is a law of *inertia*. The reactions we make to stimulation all have a certain momentum, and this momentum, by affecting the succeeding response, affects also our judgment. Now Weber found that these judgments do not proceed in a haphazard manner, but follow according to a certain ratio. For example, I lift a one-pound weight which I call the standard by which

other weights are to be judged. Then I am offered weights of fifteen and seventeen ounces respectively, whose difference from the standard I am unable to detect. But if, upon being offered weights of fourteen and eighteen ounces, I say of the first, "that's lighter," and of the second, "that's heavier," the threshold of difference will have been reached. From this it is apparent that I can appreciate a difference of one-eighth in lifted weights. Now present to me a weight of two pounds. I lift it and call it the standard, thereby establishing both a physical momentum in my arm and hand, and a psychical momentum in my response mechanism. Immediately afterward I lift weights of thirty-one and thirty-two ounces. Will I detect the difference between them and the standard weight? No. Will I even detect the difference between weights of thirty and thirty-four ounces and the standard? I will not. For since one-eighth is my ratio, it will require a weight of either twenty-eight or thirty-six ounces lifted after the standard to annul the inertias in my arm and my response mechanism.

Applied to the perception of space, this law means that even though we are always making mistakes in our judgments of distances, extents, rates of motion, and depths, nevertheless, since we are constantly making the same percentage of error, our relationship to the environment of space remains relatively the same. Thus, while we constantly make mistakes, our errors are nevertheless constant, uniform, and calculable. They follow an invariable formula.

Let us here illustrate and explain some of the more common illusions of space. The underestimation of vertical lines is, with the unpracticed eye, universal. In each of the following figures the horizontal and

vertical distances are the same. The error in estimation is due to eye movement. It requires greater effort to elevate the eyes than swing them from side to side, and we tend to make judgments on the basis of our expenditure of energy. Again, we tend to overestimate the size of all acute angles, and to underestimate the size of all obtuse angles. This is

doubtless due to our experience with table tops, floors, walls, ceilings, and rectangles of all sorts, whose angles, through being seen in perspective, appear as either acute or obtuse. We have constantly to judge such angles as right angles, in spite of their appearing otherwise, and the momentum of these past judgments affects our estimate of all the

other obtuse and acute angles which we see. It is on this account that the circle with the square inscribed seems broken at the corners of the square. But another explanation, equally based on motor responses, is also possible here. It is a theory based on the principle of *empathy*—the tendency to feel oneself into the situation. On this theory all acute angles make us feel cramped and huddled, and all obtuse angles make us feel *as if* we were stretching and yawning. In the case of the square inscribed in the circle, we read our own kinæsthetic squeezes into the meeting point of arc and chord.

The next figure, Poggendorff's illusion, is due to erroneous eye movement. The sections of the broken line do not appear to be continuous for the reason that the eye, in reading the figure from left to right

(as is our custom with all printed matter), leaves the diagonal for the vertical, with the result that it keeps moving over to the right too high up, and consequently gets "off the track."

The following illusion is due to the fact that the eye, in reading the design, stops at every line, there-

by inducing the judgment of greater distance in the direction in which the eye is traveling. As a matter of common observation, "filled" space usually appears larger than "unfilled" space. This may be

observed in the case of these dots, as well as in the case of furnished and unfurnished rooms. A large theater with the chairs removed looks amazingly shrunken in size. By employing this principle judi-

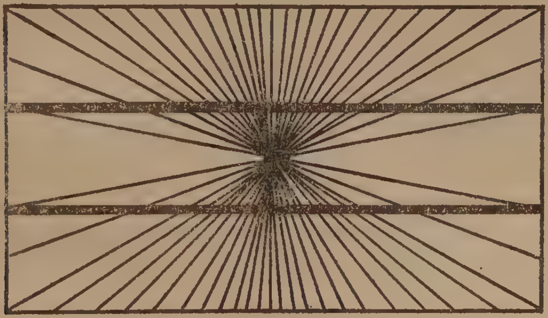
ciously, many a small inclosure can be made to look remarkably roomy. There is a little park within the grounds of the University of Pennsylvania which, on account of the numerous, winding paths, each hidden from the other by hedges, appears to one strolling within it to be several acres in extent.

The following figure illustrates the Müller-Lyer illusion. "The two horizontal lines are equal in

measurement; they are unequal to the eye. Why? One suggestion is that *the eye moves freely along the one, and obstructedly along the other;* the obliques tempt out, in the one case, and hem in, in the other. The suggestion can be tested; for movements of the eyes can be recorded; and it turns out to be correct. The eyes, in passing over a line, like the lines of the figure or of a printed page, move by sweeps or jerks; they go so far, halt, and start again. Experiment

shows that movements along the upper horizontal take a longer sweep, and oftentimes come to a halt only when they have shot beyond the end points of the line; whereas movements along the lower horizontal are themselves shorter, and frequently come to a halt before the extremities of the line have been reached." This illusion may be varied in several ways without losing its striking character.

Hering's figure, given below, produces its characteristic illusion because it contains such a great number of obtuse and acute angles, each of which is wrongly estimated. Besides, we begin to read it at the left, where the skew is the greatest, and where



consequently the momentum toward error can be established the most easily.

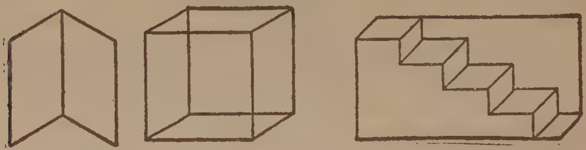
Some illusions are due to contrast effects, as in the case of the following circles, lines, and plane figures. In such cases we take unconsciously one dimension as the standard, and it is the amount of energy ex-

pended to overcome the inertia thus established that determines our consciousness of error.

A final class of illusions may be said to illustrate our educated and inveterate tendency to see all things possible as if they were space-filling objects. The book shown on page 190, as well as the reversible cube and staircase illustrate this tendency to a remarkable degree. Precise experimentation has

revealed that every time these figures appear to change their relation to us, our eyes have moved to fixate a different element of the design, thereby bringing it into the foreground.

With this our explanation of the perception of space draws to a close. This account, be it noted, is far from complete, inasmuch as it leaves untouched, and almost unhinted, the psychological significance of thousands of common and uncommon words which imply spaciality to us. Suffice it to re-



mark, however, that all terms meaning region, location and change of place, presence, absence, abode, and habitation; receptacles and their contents; largeness and littleness; expansion and contraction; remoteness and propinquity; altitudes and abysses; summit and base; zenith and nadir; pendency and support; parallelism and obliquity; outside, inside, and edge, as well as a host of other terms relating to motion, form, dimension, and capacity, are one and all derived from our discriminative responses to the extended world about us. Indeed, so much does space concern us, and so inveterately do we tend to think in spacial terms, that we have even come to employ them in speaking on moral matters. Originally "right" meant "straight," while "wrong" meant "crooked." Similarly we speak of the *"highest* good" and the "lowest depths of infamy." A full account of psychology of space would not only explain the mechanism whereby we make all these varied re-

sponses, but it would also seek to explain how much real meaning attaches to such expressions as "infinite distance" or "unfathomable void." For it is readily understood that if all mental processes depend upon motor responses, some of these more "comprehensive" terms have much less real meaning than one might at first suppose. That is to say, they arouse in us a host of undirected and unfinished reactions rather than any single, specific, motor response. It is only because such comprehensive terms evoke sentiments of unrest and unquiet that they seem to us to have such a profound and significant meaning.

CHAPTER XVIII

THE PERCEPTION OF TIME

OUR word "time" comes from an ancient Greek verb which means "to cut," and the inference is that time is like a ribbon or filament from which pieces of varying lengths may be snipped off. Paintings of the "Three Fates" hint a similar notion: Clotho spins the thread of life, Lachesis twists it into varying diameters, and Atropos, "the blind fury with the abhorred shears," severs it, and we die. It would seem, then, that time is *like* space in that it may be regarded as something which may be divided and partitioned; but, on the other hand, it is *unlike* space in that it has only one dimension. For while in space there is a right and left, an up and down, and a forward and back, time offers only a before and after, or a past and a future, between which we sometimes discern an interval which we call *now*. No, even this is too much to claim, for future time exists for us only in our expectations—psychologically, "time to come" is simply an inveterate habit of our thought.

This does not mean, however, that time is merely a figment of our imagination, for if this were the case, not only might we all be able to jump from Monday to Wednesday without any Tuesday intervening, but each man might also construct his own calendar and clock to advance at any rate that suited him. And if we ask why such individual whims do

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TESTING QUICKNESS OF RESPONSE. The man at the right gives a signal. The man at the left records it. The machine registers the time elapsed between signal and record.

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A TEST IN JUDGING WEIGHT. The weights are placed on a revolving table. The subject picks up one at a time and reports instantly his judgment of its weight.

not abound, the answer is that the basis of our notion of time is derived from the rhythms of nature, and not from our own caprices.

Rhythm, then, is the ultimate basis of time. The sequences of sun and moon, of the seasons with their blossoms and snows, of the tides and of the winds, and of countless other cosmic events impress us with the notion of change. Our own breathing and heart-beat furnish similar hints of "before" and "after," as well as do our bursts of emotion and their gradual fading away. From all these we get the general impression of a push and flow of events, and it is to this that we give the designation of *time*.

Yet all these rhythms and changes would not produce the effect of a push and flow of events were not our physical nature so organized as to receive and respond to such varied impressions in a certain special way. Many years ago, William James, in writing on this same topic, employed the expression "the *stream* of consciousness." Prior to his time, the words "chain" or "train of thought" had been widely employed to describe the mental process. "It is nothing jointed," said James, "it *flows*." The metaphor is appropriate, and good metaphors are especially valuable to the scientist. But yet this question remains, "Why does the word *stream* more fitly describe thought than does any other word?" The answer is not hard to give. Our response mechanism is made of a flexible, fluid, plastic, and buoyant material, which transforms great quantities of energy in an entirely unobtrusive manner. It is, moreover, due to this labile background of unconscious responses that the upper consciousness derives its streamlike quality. And since, as we have shown before, we frequently interpret the environment in

terms of our own responses, the fluid or ribbonlike quality of time is derived from our tendency to react empathically to the rhythmic world about us.

Such a tendency is shown in our estimation of what are called "filled" and "unfilled" time intervals. The hour spent alone in the railway station waiting for the overdue train seems much longer than the hour spent in dancing with an altogether lovely and fascinating partner. Both may be 60 minutes long by the clock, but they are not equal so far as the kinetic system is concerned. Again, "time filled with varied and interesting experiences seems short in passing, but long as we look back. On the other hand, a tract of time empty of experiences seems long in passing, but short in retrospect. A week of travel and sight-seeing may subtend an angle more than three weeks in the memory; and a month of sickness yields hardly more memories than a day. The length in retrospect depends obviously on the multitudinousness of the memories which the time affords. Many objects, events, changes, many subdivisions, immediately widen the view as we look back. Emptiness, monotony, familiarity, make it shrivel up."

It is a frequent remark that "The same space of time seems shorter as we grow older—that is, the days, the months, and the years do so; whether the hours do so is doubtful, and the minutes and seconds to all appearances remain about the same. An old man does not probably *feel* his past life to be any longer than he did when he was a boy, though it may be a dozen times as long."

"Tedium, ennui, boredom, are words for which, probably, every language known to man has its equivalent. It comes about whenever, from the relative emptiness of a trace of time, we grow atten-

tive to the passage of time itself." "Close your eyes and simply wait to hear somebody tell you that a minute has elapsed, and the full length of your leisure with it seems incredible. You engulf yourself into its bowels as into those of that interminable first week of an ocean voyage, and find yourself wondering that history can have overcome many such periods in its course. All because you attend so closely to the mere feeling of time *per se*, and because your attention to that is susceptible of such fine-grained successive subdivision. The *odiousness* of the whole experience comes from its insipidity; for *stimulation* is the indispensable requisite for pleasure in an experience, and the feeling of bare time is the least stimulating experience we can have. 'The sensation of tedium is *protest*,' says Volkmann, 'against the entire present.' "

There is a difference between the manner in which we estimate periods of time shorter or longer than three or four seconds. The estimation of longer intervals than four seconds is made, as we have already shown, on the basis of the events that fill them. The short intervals of time are ordinarily measured either on the basis of strain sensations, or by means of such organic rhythms as the breathing and the pulse provide. "Breathless with expectation" is a common phrase which indicates how important a part our strain sensations play in the estimation of time intervals. Suppose we are comparing the times it takes for two trap shooters to sight and fire at clay pigeons. The strains commence at the first sight of the first target, and increase in intensity until the shot is fired. They begin again at the sight of the second target, and when they have reached the same intensity as at the end of the first interval, it is

judged that the two intervals are equal. Such periods of expectation "do not ordinarily last more than three or four seconds without relaxation, and even at three seconds become very unpleasant. This is evident to anyone who has watched the movement of a clock with a slow torsion pendulum, or any similar slow rhythmic movement. The strain of waiting for the turn becomes unendurable after a short period."

Just as we inquired in the chapter on the Perception of Space how much real meaning attaches to the word "infinity," so we may ask here how much real meaning attaches to the word "eternity." Now it is of course plain that just as "the feeling of past time is a present feeling," so must it be with our feeling of eternity. We cannot "check up" on the correctness of our idea, since our span of life does not extend far enough. Nevertheless, the word "eternity" has some sort of meaning, vague and unspecific though it be. For just as we can follow with our thoughts the notion of "space extending on and on," so we can comprehend a similar notion with respect to time. But in every such case our thought is generated by motor responses which furnish alternate feelings of linger and strain in quick succession. Both infinity and eternity are, then, more or less unreal. Whenever such words are mentioned, we simply do our best to react *as if* there were such endlessly continuing spaces and times. But frankly we do not know whether there are or not.

CHAPTER XIX

ASSOCIATION

THE law of the association of ideas is as old as psychology itself. Very early in the history of our science it was recognized that there was a certain definite order and sequence in our thinking, and an attempt was made to find the exact formula for it. The Greek philosopher Aristotle stated four principles to account for the succession of ideas in our minds:

1. Association by similarity, as, for example, when upon seeing a stone wall we think of other structures built of stone;

2. Association by contrast, illustrated in the case of the sight of a bankrupt man recalling in our minds his former happier state;

3. Association by succession, exemplified in the case of a person, who, being shown a piece of cloth, imagines the steps by which it can be made into a garment; and

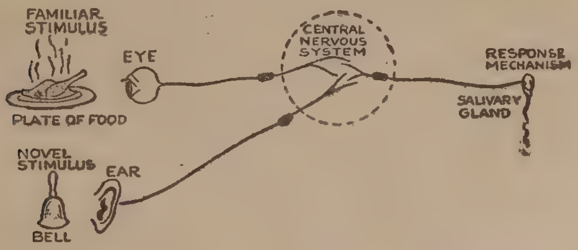
4. Association by contiguity in time and place, a principle employed whenever a hat brings up the idea of a head, a pair of gloves the hands that wear them, fire smoke, and sunsets supper time.

Modern psychology, however, is not content with merely classifying the connections between ideas; it wants to know how and why such connections are formed in the first place. And the answer to this question is simply this: that all associations be-

tween what are called *ideas* are originally associations between *things*, and that these bonds are made whenever we take an active interest in what is going on about us. As interests differ, so do associations. The word "bark" calls up the word "tree" to a woodsman, while it arouses the idea of "dog" to the keeper of the kennels. It is due to our dominant interest, our bias, our temperamental disposition that most of our associations are formed. The mention of the word "stone" brings up one sort of association in an architect, another in a knife grinder, another in a flour manufacturer, and still another in a man within prison walls. In this sense, associations are equivalent to *habits of thought.* The principles enunciated by Aristotle are, then, more or less inadequate, since they do not give any reason why ideas of similarity should be awakened in one mind, ideas of difference in another, ideas of succession in a third, and ideas of contiguity in the fourth. Aristotle's laws of association are rather classifications of all the possible connections between ideas. The kind of mind that he was describing was a mind like his own—a mind with a severely logical bias.

Let us now look at the mechanism by which associations are formed. This mechanism is called the "conditioned reflex," and our knowledge of it is due largely to the investigations of the Russian physiologist N. Pavlov. Professor Bayliss, in his "Principles of General Physiology," gives the following account of the formation of these conditioned reflexes. "A dog, when given food, secretes saliva, as is well known. Suppose that every time the food is given a particular bell is rung. After a number of repetitions of the combination of bell and food, *the sound of the bell alone* is found to cause the secretion of

saliva." Moreover, it is the sound of this particular bell, not just *any* bell, that will make the dog's mouth water, for it was shown that if the dog had been accustomed to receive food when middle C had been sounded, the note C sharp was heard without producing any salivary response. A similar conditioned reflex could be produced by the aid of a colored plate. For example, if this particular dog had always been fed from a blue plate, the sight of the blue plate alone would invariably cause the flow of saliva, while plates colored red, white, green, or yellow, would avoke no such reaction. We may, then, state the law of the conditioned reflex: "If a new, indifferent, external stimulus is many times present along with one which has already a definite response, the subsequent presentation of the new stimulus causes the reflex to be given." (Bayliss.) The scheme of the nervous connections involved in the formation of an association between the sight of the food and the sound of the bell may be indicated by the following diagram.



The two stimuli acting simultaneously not only gradually wear down the resistance of the synapses in the central nervous system, but they also accustom the final common path to respond to either stimulus with equal ease. Hence, when later on only the bell

is presented, the salivary reflex takes place as readily as if the plate of food were also shown. In the case of the reflex conditioned by the blue plate, both stimuli, the familiar and the novel, are received through the eye.

The great bulk of the nervous system is in the brain, and the brain is almost entirely made up of connector, that is association, fibers. This accounts for the tremendous variety of associations in the educated individual. The nervous system is so organized, and especially the brain is so full of interconnecting pathways, that any novel stimulus can be employed to evoke any familiar reaction, providing the connection between the two is made often enough to establish the necessary brain habit.

The formation of conditioned reflexes is also hastened by means of language. Words are not only associated with things, but also with each other. This results in our doubling the connections between the objects of the external environment. For we not only see, hear, and touch many things at the same time, but we also learn to call them by name, and this means that hundreds instead of dozens of nervous pathways are then learning to transmit their stimulations toward the same final common motor pathway. It is for this reason, perhaps, that language is regarded as the highest instrument of human intelligence.

All associations whatever are based on this law of the conditioned reflex. Not only does the sight of the dinner table make us think of eating, but even the menu card on which our favorite foods are mentioned can cause our mouths to water, so fully have our various eating reflexes been *conditioned* by these novel stimuli. Our whole school education consists

of the formation of conditioned reflexes in an orderly manner, passing from the familiar to the unfamiliar and from the simple to the complex. The familiar is connected with the novel by being mentioned along with it, and, due to the frequent repetitions of the connection, the association becomes firmly established.

Pavlov's Law, the law of the conditioned reflex, is thus the fundamental law of all thinking. Whatever things have been experienced together or in reasonably quick succession tend to recall each other when only one of them is present. We learn what is new by tying it to something that is familiar, and thus advance in intelligence. The acquisition of a new language is difficult only because so many hundreds of conditioned reflexes have to be formed in so short a time. Moreover, we unify and weld our many experiences together because the novel stimulus always evokes the more familiar reaction. Things always get their meaning from the number of deeply ingrained associations they arouse. Contrariwise, the stimulus which arouses no associations whatever means nothing to us. The thinking process is, then, the constant interplay between novel stimulations and familiar associations; both are required in order that the stream of thought should flow at its normal rate. For if we learned nothing new, we should be idiots, and if we forgot all that was familiar, we should be demented; it is therefore due to this constant knitting together of experiences that we possess any degree of mental unity whatever.

We are now ready to explain what is meant by the word *idea*. When we say that ideas are associated in our minds, we really mean that we are thinking of absent objects or of situations which are no longer

present. The word *idea* is a rather tricky one to define, for, if you look it up in a good dictionary, you will find that it means a dozen or more different things. But in psychology, and especially in connection with the topic we are now discussing, ideas are really reactions which are carried out without the normal stimulus to such reactions being present. Let us call them *"as if"* reactions. For example, if I mention the word "apple," and you say that you are thinking, i. e., have an *idea* of the object I mean, you really react more or less *as* you would *if* an apple were really present. Likewise, when a person says, "I have an idea that it is going to rain," he is then reacting to some degree *as* he would *if* rain were falling. Strictly speaking, the noun "idea" is an unfortunate word, for ideas have no existence independently of ourselves. What we should rather say is that we *ideate* the apple and the rain. In this sense ideas are equivalent to imaginations, that is, fictions of the mind, which represent objects in their absence.

All imagination, then, is due to conditioned reflexes, and the so-called "pictures of fancy" which we produce are more or less vivid accordingly as the conditioned re-arousal of the response is strong or weak, that is, accordingly as the amount of energy we then expend is great or small. In previous chapters we learned that there is no sensation without motor response, and also that whenever there is a motor response, no matter how it is aroused—whether by an external stimulus or not—we have some form of consciousness as a result. Ideas, then, come about whenever a stimulus spreads its excitation to other motor pathways than those which are normally required to produce a response. When you

say "apple" and imagine the sight of the fruit, the stimulus of your voice arouses much the same motor responses as would be produced were the object itself stimulating the retina, and that is why you seem to see it before you. For just as the sight of an apple brings up its name, so does its name bring up a faint picture of the fruit itself, and this response is produced by the motor fibers of the optic nerve upon the sensitive plate of the retina. It is, of course, due to the millions of conditioned reflexes we have acquired that the flow of imaginations in our minds is so continuous.

There are several things that determine which associations shall be formed. One of these is our needs and desires. When left to ourselves, whether in infancy or in middle life, our associations tend to be made on the basis of our spontaneous interests. The child wants to find out the "go" of everything which he sees and handles, and his exploration of the environment leads to the formation of an entirely different set of conditioned reflexes than would be made if he were hampered by restrictions of various sorts. Likewise, the adult person while off on his summer vacation makes acquaintances with nature and people that would never be made in the environment of his regular work. Another influence which establishes associations is our educational system. The books in the public school curriculum are planned for the purpose of establishing habits of thought quite different from those that would be formed without their guidance. Moreover, the author of one textbook in arithmetic aims to build up one sort of associations, while the author of another book on the same subject proceeds to the establishment of another sort. A third important fac-

tor in determining associations is the influence of other people, such as parents, brothers and sisters, employers, political leaders, and so on, from whom we get both early and late in life all manner of influences for the establishment of associative tendencies.

Our "home ties" are one and all associations, as well as are our politics, patriotism, and religion, our aim in life, our philosophy, and our ideals among the opposite sex. Indeed, every mental characteristic we possess may be analyzed into a group of conditioned reflexes. And as our elementary education forms them, so often our higher education tends to demolish them in order to plant better and more intelligent tendencies in their stead. Indeed, civilization may be interpreted as the struggle to establish the most permanently profitable conditioned reflexes in the human race.

The factors that determine which one of the many possible associates will arise at any given moment are usually stated to be four in number. These are (1) the number of times the association has been made, (2) the recency of the association, (3) its vividness, and (4) our present interest and emotional tone. James writes of the first two of these factors: "Thoughts tend, then, to awaken their most recent as well as their most habitual associates. This is a matter of notorious experience, too notorious, in fact, to need illustration. If we have seen our friend this morning, the mention of his name now recalls the circumstances of that interview, rather than any more remote details concerning him. Excitement of peculiar tracts, or peculiar modes of general excitement in the brain, leave a sort of tenderness or exalted sensibility behind them which takes days to

die away. As long as it lasts, those tracts or those modes are liable to have their activities awakened by causes which at other times might leave them in repose. Hence, *recency* in experience is a prime factor in determining revival in thought." On the subject of vividness James remarks: "If a man in his boyhood once talked with Napoleon, any mention of great men or historical events, battles or thrones, or the whirligig of fortune, or islands in the ocean, will be apt to draw to his lips the incidents of that one memorable interview. If the word *tooth* now suddenly appears on the page before the reader's eye, there are fifty chances out of a hundred that, if he gives it time to awaken any image, it will be an image of some operation of dentistry in which he has been the sufferer. Daily he has touched his teeth and masticated with them; this very morning he brushed, used, and picked them; but the rarer and remoter associations arise more promptly because they were so much more intense."

And of the fourth factor James writes: "The same objects do not recall the same associates when we are cheerful as when we are melancholy. Nothing, in fact, is more striking than our inability to keep up trains of joyous imagery when we are depressed in spirits. Storm, darkness, war, images of disease, poverty, perishing, and dread afflict unremittingly the imaginations of melancholiacs. And those of sanguine temperament, when their spirits are high, find it impossible to give any permanence to evil forebodings, or to gloomy thoughts. In an instant the train of associations dances off to flowers and sunshine, and images of spring and hope. The records of Arctic or African travel perused in one mood awaken no thoughts but those of horror at the

malignity of nature; read at another time they suggest only enthusiastic reflections on the indomitable power and pluck of man."

It is, however, apparent that if there are so many factors controlling both the formation and the reappearance of associations, mind is much more complex than the naive person might suppose. And, indeed, the longer we study the mind and the deeper we probe into its workings, the more complicated do we find it to be. Nevertheless, the complexity with which we meet is all a complexity of *detail*—the fundamental facts and laws and the underlying principles we have previously enunciated hold from first to last.

This outline of association would not be complete without some mention of dissociation. For we not only *connect* some of our experiences together, but we also *disconnect* others, that is, *dissociate* them from the stream of our thought. Some of these are willfully suppressed, such as unpleasant incidents and irrelevant details; others are lost simply because they are not repeated often enough, such as the price of an article bought many years ago; while still others are suppressed through the conflict of motives and desires clear below the level of consciousness, that is, in our unconscious and subconscious minds.

But here we touch upon a topic so large in scope and so varied in detail that were we to pursue it to any satisfactory length we should have to devote all the rest of our pages to it alone. For we here stand on the threshold of abnormal psychology, a subject so comprehensive and vital that to-day it is by some regarded as the only proper introduction to a study of normal mental processes. We can give

it only scant mention here and there in the chapters which are to follow, but to any reader who wishes to understand its application to the psychology of everyday life we recommend Edwin Holt's "The Freudian Wish" as a book not only scientifically sound, but fascinatingly and sympathetically written as well.

CHAPTER XX

MEMORY

A VERY good introduction to the study of memory is James's definition of it. "*Memory*," he says, "*is the knowledge of an event or fact*, of which meantime we have not been thinking, *with the additional consciousness that we have thought or experienced it before*." Memory, then, has a definite connection with our perception of time. We imagine the future, perceive the present, and remember the past. But surely not all of the past? No, for no man living remembers Julius Cæsar, or the Discovery of America, nor does the average man remember even how many steps there were up the stairway in his boyhood home. For just as every man's memory is restricted by his span of years, so is it partial to certain events and objects experienced within that time. As James remarks again: "Memory requires more than mere dating of a fact in the past. It must be dated in *my* past. In other words, I must think that I have directly experienced its occurrence. It must have that warmth and intimacy characterizing all experiences appropriated by the thinker as his own."

The fact that memory is so partial to certain facts or events of our past is to be explained chiefly in terms of bias or interest. Very early in life we acquire our dominant traits of mind, and these thereafter act as directive agencies, welcoming this and

rejecting that feature of our experience. These dominant traits are really habits of response learned by the kinetic system. What is welcomed is also retained or remembered, while what is rejected is suppressed or forgotten. The process of remembering is largely the building up of associations about the fact to be retained, while forgetting is due to the breaking up of associations, that is, to dissociation. Nothing, then, is remembered alone—it always requires associations to retain or recall it. Association, therefore, underlies all memory. You are shown something you have never seen before, and are asked to remember it. How do you proceed? You try to name it, classify it, describe it, think of it as *like* something you already know as well as *unlike* something else you know; you think of the time, the place, and the name of the person who shows it to you, and so on. But all this is simply forming associations. Naming and classifying, for example, is nothing but establishing relationships between the novel and the familiar; so is describing, and so are all the other schemes you devise for the purpose of fixing the object in your mind. Contrariwise, when you forget it, it is because of a break in the chain of associations previously formed about the forgotten fact.

The nervous basis of memory is not difficult to conjecture. In the first place, memory is a form of motor activity. To remember means to rethink something, and to date the recollection in your past. The rethinking is, of course, due to the activity of previously practiced motor pathways, and the dating of the recollection is due to the fact that numerous precise associations are simultaneously awakened. But associations themselves are likewise motor ac-

tivities, and hence the whole process—the rethinking and the dating—is brought about because many motor responses formerly active together are again awakened simultaneously. Usually, of course, we actually assert the time and place of the remembered fact, and this motor activity of the speech mechanism—whether audible or "subvocal"—completes the whole response.

This account, of course, sounds far more elaborate than it *feels* to remember, for a flash of thought which reveals a yesterday is over and gone in a brief quarter of a second. But all scientific explanation whatever is slower than the facts it records and analyzes. It takes a mathematician much longer to compute the curve of a projectile than it does for the projectile to find its mark. The explanation of all events is slower than the events themselves. It requires only a moment for boys to start a fight, but it often requires much tedious circumlocution for their parents to fix the blame for it.

The experimental study of memory reveals four rather distinct stages or steps in the process: (1) the stage of *impression*, during which the fact to be remembered is brought to our notice; (2) the stage of *retention* or the interval between the impression and the recollection; (3) the *recall*, and (4) the *recognition* of the fact as a bit of our previous experience. These four steps are not, of course, distinguished in ordinary life, for very few of us give any careful thought to our memories—we either remember or do not remember, and that is the end of it. These four steps are, nevertheless, scientifically demonstrable, but, on the other hand, they are so blended together and interdependent that each is valueless without the others. "Learning without

retention is almost a contradiction in terms. Retention without recall is equally futile. Retention, in fact, can be demonstrated only through recall. The knowledge stored in your brain at this moment gives no sign of its presence. You can be aware of what you know only through recalling it. Finally, if events when recalled were not recognized, recall would be valueless. If when an idea came into your mind you could not say whether it was derived from a dream or a real experience, it would be merely confusing. Statements that you remember you have read but cannot refer to a definite book or time can be little relied upon."

The first two stages in the memory process are by far the most important. The impression and retention of the fact to be remembered are nine-tenths of the battle. Errors in recalling and in recognition are one and all traceable to defects in the early stages of the process. Much excellent experimentation has been carried out in the field, and the following laws of learning have been discovered:

1. The clearer the first impression is the better will it be retained. And, moreover, nothing can really make up for a cloudy first impression. If, for example, you are given a telephone or automobile number to remember, and it is told you in either a careless or hurried manner, or, worse, if it is given you doubtfully and incorrectly and has to be corrected, the chances are that it will not stick at all in your memory. On the other hand, if you are given time in which to prepare to listen to the information, and then if it is given to you at a rate that you can easily follow, and if it is given without the distraction of extraneous stimulations, so that your mind and that of your instructor can meet and fuse for

several seconds, the memory of the number will be completely established in your mind.

2. In general, the greater the number of single impressions, the better will the material be retained. But it must be borne in mind that each single impression still needs to be equally *clear*. Jumbled impressions given at too great a speed to allow new associations to be constantly formed and fixed are a positive detriment. For the succeeding impressions to sink deeper and deeper into the mind, they should arouse now wider and now more precise connections with familiar things. Associations are the digestive juices of the mind, and without them no assimilation of new material is possible. Mental digestion should never be unduly forced or hurried.

3. If one is learning a set speech, a poem, or any fairly lengthy material, it is better to distribute the repetitions than to attempt to take them all at one sitting. To be sure, much that we are obliged to remember must be learned in a short time, but even so it is bad psychology to attempt to "gobble up" more than can be properly assimilated. Perhaps the reason why "cramming" in college is so prevalent is because students have ceased to trust their powers of assimilation, and are consequently fearful of forgetting. But it needs to be known that rest pauses in learning are just as important as any other steps in the process. Indeed, it is during such times that valuable subconscious associations are automatically supplied, *whether we are thinking of the material to be remembered or not*. Only a small percentage of our mental activity ever becomes conscious. Moreover, the subconscious mental processes really perform all the heavy mental work that we do. Fear disturbs, while confidence guarantees

the integrity of these subconscious processes, without whose presence no new material can be satisfactorily assimilated.

4. The nature of the material to be learned determines the method of impression. If one is learning a list of disconnected telephone numbers or unrelated history dates, they are best taken in isolation from one another. On the other hand, in learning a paragraph of prose, a stanza of poetry, or a series of operations in a manufacturing process, "it is advisable to read through the whole from beginning to end, and to repeat the reading until all is learned, rather than to learn bit by bit." For if one proceeds to repeat the first line or phrase of the material over and over again, one establishes the habit of this repetition rather than the more essential habit of going forward to the next part. "The only objection to learning by wholes is that one is likely to lose interest in the work when no progress can be noticed, and to read more slowly than usual. This may be obviated by making pauses at the natural points of division without going back to the beginning. It is also advisable, after the selection is partly learned, to repeat the harder parts more frequently than the easier. These methods combine the marked advantage of learning as a whole with the greater interest that comes from observing progress in the task. When this rule was observed some investigators demonstrated a saving of from 20 to 50 per cent in the repetitions required for learning."

5. The organization of the material to be learned into headings and subheadings hastens assimilation. This is because such a method is equivalent to the establishment of the most helpful associations with which we are acquainted. For order, coherence,

sequence, and the like are themselves typical of natural events, and our fixed acquaintance with such things makes all similar arrangements of words, phrases, and facts fall pat within our experience.

6. Rhythm aids learning on account of the immense labor which rhythm saves us. For rhythms are one and all groupings of stimuli about one of their number which receives an accent. Our response mechanism is so constructed that when a certain rhythm is started in us it requires only the maintaining of the accent to enable us to perceive the contents of the succeeding groups. Rhythmic material is thus almost automatically assimilated. Medical students are wont to remember the names of the twelve cranial nerves by means of some such doggerel verse as the following:

On......	Old..	Olympus'..	Piny...	Tops.....
Olfactory	Optic	Oculo-motor	Pathetic	Trigeminal

A.......	Fat....	Armed..	Girl...........	Picks........
Abducent	Facial	Auditory	Glossopharyngeal	Pneumogastric

Snowy..........	Hops......
Spinal accessory	Hypoglossal

7. Learning is hastened if the material is repeated with the full intention of recalling it, and especially if the precise time of recall is determined upon and known. This amounts to giving the subconscious mind definite instructions, which instructions will be carried out faithfully provided the material is properly presented and the belief in its recall is not shattered by fear or self-mistrust.

8. If one tries to repeat from memory as soon as possible, fewer repetitions are required than

otherwise. Dawdling along without any determination to master the material not only lengthens the learning time, but it also really weakens the associations already formed. Moreover, the repetitions should be at a rate to require and command a full interest rather than at so slow a rate as to invite distractions and irrelevant thoughts. And if the person enters actively into the repetitions rather than simply "lends an ear" to the reiterations of another, the learning will proceed much more rapidly. For since the purpose of the impressions is to guarantee future reproduction, the sooner the reproducing begins the quicker will the material be fixed in the mind.

One of the most interesting facts which the scientific study of memory has revealed is the extent to which we may be confident in our reports of past events which never happened at all as we recount them. Memory is, indeed, largely a tissue of illusions. Of course most of us remember truly whether we ever saw Niagara Falls or not, but we are just as likely as not to assert that we saw it on a sunny day, whereas the fact of the matter is that it was cloudy and rainy. In such a case we recall not our visual impression of the physical fact, but rather the pictures of the falls which we have seen, all of which were taken on cloudless summer days. Similar errors can be detected in the reports of all our acquaintance respecting their past experience.

The reasons for this loss of accuracy are at least threefold. To begin with, all new impressions whatever must be assimilated by old experiences before they can be incorporated in our minds. Consequently, they are all interpreted in terms of previous and, maybe, faulty impressions. This assimila-

tion and interpretation always distorts the new impression—we always perceive it *our way*. A public speaker realizes the presence of such bias when he puts the same thing to his audience in several ways, or when he introduces a new principle by several different illustrations, so that everyone in his audience will get it. But they do not so much get *his* ideas as they reshuffle their own. Often his ideas are more or less lost in the course of assimilation by his audience. A second cause of the unfaithfulness of memory is that in so many of us "the wish is father to the thought." Try as we may to abort the momentum of individual bias, its influence spreads to every nook and cranny of our minds. A third reason for the fallibility of memory is the rapid disintegration of response tendencies which are not frequently enough released into action to "keep in trim." Figuratively speaking, our memories "need air." Recollection should not only be frequent, but it also should be checked up by reference to the facts in order to deserve the confidence we place in it. In general, "forgetting goes on very rapidly at first, then more slowly, until finally there is no appreciable change even over long periods of time. Ebbinghaus found that with series of nonsense syllables half of the learning was lost in the first hour; two-thirds the first day; while at the end of the month less than four-fifths was forgotten. In ordinary learning, details disappear very quickly, while the more general principles are remembered for a long time."

A fourth reason for the imperfections of memory is found in the conflict of associations. It is as hard to keep apart two men who look nearly alike, but who have different names, as it is to avoid confusing the faces of different men bearing the same name.

Groups of associations that have common elements readily exchange places in our minds, and thus aid in destroying the integrity of our memory for either fact thus related. And still another cause of the decay of memory is that our *mental direction* is normally forward into the future rather than back into the past. For while the past may be the source of much of our mentality, it can no longer be the field of our action. Hence the loosening up of former associations, the decay of old landmarks. For mind is an instrument to assist us in our adaptation to, and control of, the environment, and consequently the greatest efforts we expend are concerned more with the realization of hope and ambition than with the relics and memorials of the past.

If, then, it is asked: "Can memory be perfected so that no thought will slip from us?" the answer is "No." The most we can do is so to organize and systematize the facts that are important for our life of action that they will have order, sequence, and interdependence. This is the only true basis for memory training, and the only scheme that is worth the time expended upon it. All other so-called "memory systems," advertised widely and sold for a good profit, whose promoters promise to perfect your mind so that not a leaf will fall to the ground without your being able to retain its date in your memory, are a symptom of commercialism rather than a product of the psychological insight of our times.

CHAPTER XXI

IMAGINATION

IMAGINATION is one of those many-sided words which is used in popular speech for an unlimited number of purposes. Sometimes it means reverie, sometimes astute and accurate prediction; here it will be employed to refer to error and delusion, while there it will be used to indicate the most fortunate conjectures of applied science; it is equally descriptive of the mental processes of the man in delirium, of the novelist, the mathematician, and the investor in safe and negotiable securities. Jason in search of the Golden Fleece, Plato attempting to prove the immortality of the soul, Euclid seeking for the logical proofs of the truths of geometry, Napoleon aiming at a world empire, Metchnikoff searching for an enzyme to stave off old age, and Percival Lowell endeavoring to demonstrate the habitability of the planet Mars, are one and all examples of the variety and pertinacity of human imagination. So manifold and perennial a mental function as this is well worthy of study and comprehension.

Now, just as imagination has more than one meaning in popular speech, so also it has in psychology. One meaning for the psychologist is that faint representations of objects (technically termed images) previously experienced are again present in the mind, while the other meaning is that these images

are combined and used for a certain definite purpose. Let us examine these two meanings in detail.

In the first place, we can call up the images of objects previously experienced in almost any department of sensation. Upon the mention of the words we can, as it were, *see* a horse or *hear* his gallop, or *feel* the texture of his mane, or *smell* his pasture. We can also *taste* in advance the roast turkey we see cooking in the oven, or get a hint of *pain* before the dentist drills the tooth, and we can "blow *hot* and *cold*" in our minds in the presence of pictures of iron furnaces and icebergs. How is this accomplished? The answer is that all these imaginations are motor activities previously acquired in the presence of the stimulus, and which now recur more or less vividly in response to some novel stimulus which has become associated with the original stimulus. The word "horse" brings up the visual image of the animal because once both the animal and his name appeared in consciousness together. The visual stimulus of the animal and the auditory stimulus of his name once simultaneously affected us, evoking a response which we called the *perception* of the horse. This connection of sight and sound became so habitual that now the sound alone results in arousing enough of the original sensory-motor reaction to give us a visual image of the animal. The same principle explains the imaginary revival of all other sense impressions. Moreover, sounds can call up not only sights, but smells and pains as well; smells can evoke temperatures and images of movement, and temperatures can call up colors and shapes. And so much do words either printed or spoken factor into the formation of association, that books without pictures can

arouse as vivid images in our minds as do the most profusely illustrated pages. Images, then, are *revived responses*, and are one and all brought about by association. The associations do not need to be one and all conscious, for much of our imagination, such as occurs not only in dreams, but even in mathematical demonstrations, is due to factors which are entirely subconscious.

On the basis of the time and place of their occurrence, psychologists distinguish ten different kinds of images.

1. Positive after-images, which have the same quality as the stimulus, and persist after it is withdrawn. "Blow out a match in the dark, and wave the glowing stem about; you see complete circles or figures of eight."

2. Negative after-images, already illustrated in the chapters on sensation, and especially by complementary colors. "The removal of a continued warm stimulus leaves a sensation of coolness; and the swimming in the head that you feel while whirling round is followed, when you come to rest, by a swimming in the opposite direction."

3. Memory after-images, which is a term "given to an experience which is most familiar, perhaps, in the taking of dictation as you write the words last spoken, the speaker's voice still rings in your ears; the sound hangs for a few seconds, as if arrested, and your pen is guided by the mental echo. Similarly, an attentive glance at an object may set up a sort of photographic image that remains distinct for several seconds."

4. Memory colors are likewise imaginary, and are drawn from the most clear or habitual impressions of things in our experience. Regardless of the time

of day or of the illumination we see "snow as white and gold as yellow and coal as black, just because they are ordinarily or typically white and yellow and black."

5. Recurrent images, "those troublesome and haunting images to which most of us are subject at times: the tunes that run in our heads and that we cannot get rid of, the rows of figures that obsess us after a long morning of calculation, the bright disc that keeps cropping up after we have spent several hours at the microscope."

6. Tied images. "A favorite device of modern advertising is to outline the human figure only in part and to leave the remainder to the imagination;

and you will perhaps notice, if you look attentively at such a figure, that the outline, so far as the suggestion of the neighboring lines is unambiguous, is indeed complete in image, black on white or color on color; only where the completion is uncertain do the images fail."

7. Hallucinatory images, differing from all other images in that they are accompanied by an assertion of their objective reality. They are most frequent in the ultrasuggestible and in the insane, and are invariably caused by more or less serious internal disturbances. Hallucinations of sight, sound, and touch are the most common.

8. Dream images, closely related to hallucinations in that they are nearly always accepted as real events during sleep, but unlike them in that they are immediately discounted afterward.

9. Synæsthetic images, perhaps best illustrated in the case of *colored hearing*, where "any auditory stimulus arouses, along with its appropriate sensation of hearing, whether tone or noise, a visual image of light or color. The sound of the word Tuesday, for instance, may be seen as a light gray-green followed by a yellow! We might suppose, at first thought, that colored hearing is due to association, to a connection between sight and hearing set up in childhood and continued into adult life; but the evidence points to some inborn connection in the nervous system; colored hearing tends strongly to run in families. There are many other kinds of synæsthesia, besides this connection of sight and sound," for example, *phonisms* of taste, in which case the taste of a vegetable will be accompanied by a distinct auditory image, and *photisms* of smell, where the odor of lavender, as an example, will awake at once an image of a bright patch of speckled orange.

10. Habitual images, those which we each and all employ in the bulk of our thinking. Some of us are eye-minded, that is we visualize everything we can; others of us are ear-minded, employing auditory images on every possible occasion; while others are motor-minded, and require an image of movement before we fully comprehend the meaning of things.

Still others of us are wont to employ verbal images, that is, we must either consciously or subconsciously name the thing we see or hear before our perception fully matures. These types, of course, overlap, but in every man there is a strong tendency to employ one chief type of image to the exclusion of all the others.

We now come to consider the second meaning of the word imagination, namely, the use to which the various sensory images are put.

As men differ in imagery, so do their books and their speeches, their own descriptions of things and their ability to follow the descriptions of others. One novelist will rely mostly on his ability to produce as well as evoke images of the sight of the objects he is describing, another will rely entirely on the power of his images of sound, while a third will fascinate his readers chiefly on the basis of his use of images of motion. But herewith also a very strange fact comes to the light through scientific research, which is that the presence of imagery does not imply that it will be used. Some of the best visualizers, for instance, never rely on their power of visualizing either for their own advantage or for the purpose of communicating ideas to others. Moreover, the fact that a person is aiming to produce a work of art does not require that he be gifted with imagery that predicts exactly every sense impression he produces. Painters as well as musicians often use more motor imagery than they do visual or auditory imagery. Indeed, we speak of melodies *rising* and *falling*, of lines *drooping* and *swerving*, of the *balance* between light and shade in a picture, all of which terms are ultimately traceable to our kinæsthetic senses.

If we define imagination as the free combining of previously acquired sense impressions, allowing also that there may be strictly new associations forming all the while, the purpose of this mental function in our struggle to adapt to and control the environment will be at once apparent. For by our imagination we attempt to supply ourselves with an environment

other than that which is immediately present; by it we constantly push out beyond the here and the now, and seek to anticipate the future as well as to make up for that part of the past which we have forgotten. In a certain sense, imagination with its novel connections between images and its attendant feeling of strangeness, is "the modern representative of primitive man's anxiety and uneasiness in the face of the unknown." And our thoughts prowl and roam about in the same way, and often with the same doubt and insecurity as did primitive man in his treacherous jungle.

Nothing so much as language reveals the extent to which the imagination of man transcends that of the animals. For while no doubt the animals are capable of imagery, as is witnessed by the panther's stalking his unseen game and the dog's calculation of the width of the ditch to be leaped, yet man's power of naming objects by means of words so that the absence of the objects is of little importance to his thought, is an ability unique in the animal kingdom. No doubt an oyster has some sort of perceptive ability, but how do we suppose one oyster conveys to another the narrow escape he had last week from a hungry star-fish? No doubt also that many an animal *thinks up toward a word*, but there, very likely, he stops altogether; man, on the other hand, by his ability not only to reach words, but to combine them into untold numbers of differently and delicately shaded meanings, attains powers of imagination which make him the only creature capable of reshaping and controlling the physical environment. No doubt it is this particular power that is the basis of the contrast that is often drawn between *man* and *nature*.

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MEASURING FATIGUE. The device used is the ergograph, intended to test endurance.

Effects of Violent Physical Efforts. At the left, the runner's face shows his exhaustion; the runner at the right is breathing with great difficulty.

While little psychological insight has yet been gained into the nature of language, yet it is safe to say that the so-called *parts* and *figures of speech* are quite artificial divisions. Nouns, verbs, conjunctions, participles, as well as similes, metaphors and metonomies are no help to the understanding of the function of language from the point of view of the psychologist. He regards all language solely as a means to transcend the physical limitations of his environment. Speech either predicts action, or embroiders action; it gathers together elements from the past, or indicates possibilities for the future, but in any case speech is an *instrumental function*, and serves the same purposes for the organism as does its power of imagery. It helps him to expand the environment beyond the narrow limits of sensation. Speech thus not only indicates the range of our experience, but it also gives tokens of the breadth of our purposes, while at the same time it indicates our elemental anxiety and uneasiness in the face of the unknown.

Constructive or creative imagination, and especially that employed in science "for the benefit and use of men," is thus seen to be the most expansive of all the mental functions. Professor Titchener writes of this as follows: "What happens in constructive imagination is not so easy to say. Genius is defined sometimes as the capacity of doing great things without effort, and sometimes as the capacity of taking infinite pains; and constructive imagination, in the same way, is represented now as a native gift that finds rather than seeks expression, and now as a sort of skilled labor, a matter of planning and molding and constructing. There is probably truth on both sides, and a degree of truth that varies with

the individual make-up of the artist; in general, however, there is more hard work and less inspiration than is usually supposed. The poet or the inventor starts out with a more or less definite plan or aim or ambition; and the plan persists, if only as a nervous disposition, to determine the course of his ideas. It also helps to initiate the imaginative complex, the first clue to which seems in fact to come, at least ordinarily, as an inspiration, a happy thought; some external situation, or some grouping of the associative tendencies that is active at the moment, touches off the disposition, and the initial idea flashes into mind. Whether this first idea is crude or complete, and whether the stream of later ideas is broad or narrow, these things depend altogether upon circumstances. Now, at any rate, begins the stage of skilled labor; the idea is worked upon and worked over; the plan decides what shall be accepted, what rejected, what put aside for another trial; we are reminded of the course of recollection—only that rejection, active as it is in memory, is still more to the fore in imagination, and construction is more critical than reconstruction. Here and there other happy thoughts may crop up; but in essentials this stage of hard work continues, until the idea attains its final expression in objective terms, in the words of the poem, for instance, or in the effective machine. Meantime there have been all sorts of feelings. The imaginative ideas bring with them their own feelings of strangeness; but this may be overwhelmed by the joy of success or the irritation of failure; and these feelings may themselves alternate, swinging from extreme to extreme. Meantime, also, there have been all sorts of empathic experiences, which have formed about the focal processes, vivifying and

personalizing the partial products of the constructive effort; and they too find their natural term in the actual accomplishment of the imaginative task. Figurative, again, all this, and lamentably far from scientific accuracy—but, in broad outline and on the average, we may hope that it is true to the psychological facts."

This completes our account of imagination.

CHAPTER XXII

ATTENTION

THE ancient Stoics defined thought as a form of *tension*, doubtless because it required so great an effort for them to keep their minds fixedly upon the "abstract principle of Reason," which, they said, ruled the world. In so doing, the Stoics emphasized a very important element in psychology, namely, the part played by kinæsthetic strains in the continuous fixation of any object of the environment. We shall presently see just why they found it so hard to keep attending to such an abstract notion as "Reason."

The mental activity known as attention is, like all other mental processes, a sensori-motor response to stimulation. Upon analysis, it turns out to be dependent upon the operation of three principal factors. To begin with, we are said to attend whenever some sense organ is fully exposed to a stimulus that arouses a complete response. A needle pricking the toe and calling forth defensive movements from us, a dash of cold water on the back that makes us jump and murmur, a sudden clap of thunder that causes panic and hurrying for cover, a flash of light at which we blink and frown, are one and all examples of the arousal of attention through stimulation from the outer environment. Ordinarily, the dimmest lights, the faintest sounds and odors, and the lightest touches do not arouse our attention for the reason

that they do not call forth a sufficient release of energy. To be sure, other stimuli than the most intense are, under certain conditions, capable of arousing us, since many faint stimulations can sum up into a powerful excitation. Besides, attention often depends upon the area of the sense organ affected. A large, faint cloud, for example, may be seen when a small one would float by unnoticed.

Again, change of size or intensity, whether from large to small, or from less to greater, usually causes us to attend. "One notices a whistle of changing pitch or intensity where a constant one would escape notice. One even appreciates the ticking of a watch as it stops, although the preceding continuous ticking has not been noticed at all. Similarly, objects that move toward or away from us are noticed, although the same objects would escape notice if stationary, and our only way of knowing that they move away or approach is from the changing size."

So far, however, we have made no very clear distinction between attention and sensation, for all the examples given above could be cited with equal right under either of these mental processes. And, indeed, psychologists draw no sharp line between one form of attention, called *involuntary*, and sensation itself, except to point out that whenever one stimulus is producing a stronger response than any others, the field of clear consciousness begins to be narrowed, and the object so stimulating us "takes the center of our mental stage." Here, then, is something new. The things we are attending to become focal and consequential, they dominate and direct our main output of energy, while the other objects present are, by being more or less neglected, placed in the margin or background of our minds. Attention, then,

is chiefly characterized for us by a distribution of the environment into focus and margin, foreground and background, important and unimportant objects. The process of attention may be illustrated by reference to a social gathering where one after another the guests are presented to the hostess, each one pausing and speaking to her, that is, being fully exposed to her senses, while the rest are for the moment more or less out of the range of her responsiveness. Now one and now the other guest is in the focus and foreground of her mind, while the others remain in the distance as relatively unimportant objects.

The explanation for this distribution of the environment into focus and margin, foreground and background, is to be found in the principle of the *final common path*—a principle already mentioned in one of our early chapters. The nervous system is so organized that only one main pathway of response can be fully operative at any one time. Whether this is finally to be explained on the principle that the human body tends to save its energy whenever possible, and therefore releases it along only one channel at a time, is beyond the scope of this book to determine; nevertheless, we find that one vigorous nervous response automatically checks all others from occurring at that time. In this sense the body is like a great system of valves, so interrelated that when any one of them is open, the rest are closed. Attention, then, is due to the continuous release of energy along one final common pathway of motor discharge. All incoming stimuli arousing impulses that can be sent down this particular nervous pathway are welcome and acceptable; all others are rejected and left in the background of consciousness.

We now come to the second factor of attention, the factor that is responsible for *maintaining* our attention upon any stimulus that has once gotten the final common path. This factor is the kinæsthetic strain which the Stoics made of so much importance. For the natural tendency of every untrained organism is to shift its attention momentarily from object to object, and to be at the beck and call of every loud, bright, large, moving, and novel stimulus that enters the range of its sense organs. This natural tendency we often check, stopping and dwelling upon one thing, and maintaining our attention upon it even in spite of all external inducements to do otherwise. There are, indeed, rhythmic processes in our organism that are responsible for these constant shifts of attention from one thing to another. Not only does the nervous current go in waves and pulses, but even the lens of the eye, for example, changes rhythmically from farther to nearer fixation all the while. How, then, in the face of all these inducements to shift our attention, do we manage to maintain any focus continuously in our minds?

The answer is that the kinetic system, whose functions are what we popularly call our dominant cravings and our major interests, so regulates the supply of energy to one set of muscles rather than to another, that responses once begun are continuously maintained whether the sense organs are receiving precisely the same stimulation they did a moment before or not. For example, the eye is caught, as we say, by a faint but moving light. Our attention is aroused and a motor pathway set into operation. But why? Is not one light as good as another, and one motion as significant as another? By no means. For some stimulations have an imme-

diate and deep significance, and all such stimulations at once set the whole kinetic system into vigorous activity, even if such activity be totally unconscious. Now the locomotor muscles of the body are not only the great energy transformers of the kinetic system, but they are also what every final common pathway of motor discharge leads to. When, then, we maintain our attention upon one object in spite of the naturally diverting power of all other objects within range, it is because our kinetic system supplies energy for the maintenance of one kind of response rather than for another. But more even than this, for while the sense organs in the retina may not maintain perfect receptiveness toward a moving light, yet the eyeballs and the head can be kept fairly fixed and rigid so that whenever the retina does function precisely again, the eye will be in a position to receive all the stimulation that is available. But the maintenance of any such rigid posture in the eyes and head is at so great an expense of energy that considerable strains are developed in the tendons of the muscles involved. Hence the *tension* in all continuous *attention* that is maintained in opposition to seductive stimuli.

And now we come to the consideration of the third and last factor that operates in attention, namely, the constant stream of associations that must always follow upon fixation in order that the focus of thought may be maintained.

"How long, O healthy reader," inquires the romantic psychologist, William James, "can you now continue thinking of your tomb?" The answer is, Just as long as the appropriate sensations keep coming. As soon as they cease to stream in thick array, the attention wanders, and our tomb floats away to

an incalculable distance. And even though we may be in sorry mood, and generate doleful associations by the score, we cannot keep our own precious tomb in mind for more than a brief pair of seconds without thinking also of the cemetery which enfolds it, the flowers that wave near by, the monument that marks it, or the sad procession that passes by on the day of our interment. Nay, the need for constantly fresh associations becomes so imperative, that we do not hesitate to stoop to such harrowing ideas as the gravedigger's spade, our deathbed scene, and even the unlovely decay that our handsome front will have to undergo. Why? Simply because any idea, as well as any object of the physical environment, *originally got its meaning* for us from the responses we associated with it, and consequently for the meaning to be restored and kept alive, similar associated responses must now be provided. Some of the needful associations are merely settings, such as the time and place of the event, or the objects that surround it; others are significant activities, either of ourselves or of other people; but whatever they be, the associations must change from moment to moment in order that our attention may be maintained.

If it is so difficult to maintain the fixation of an object of the physical environment, how much more difficult is it to keep the mind centered upon some such abstraction as the "Reason that rules the world." What, indeed, is there in such a case that we may call the stimulus, which remains fixed and stable, and which constantly offers a point of reference for the release of our energies? The answer is that Reason, like all other highly abstract terms, is thought of only by means of concrete examples.

Sometimes it means natural law or the cosmic order, again it means cause and effect in the physical world, again the wisdom and sagacity which prudent men have manifested, while again it may refer to sanity as opposed to insanity. But all these "examples" are really *associations*, and associations, as we have just learned, are the indispensable supports of attention. So that, if we regard Reason as meaning all this variety of examples, we may consider it fairly easy to keep our attention fixed upon it. For to do so it would only be necessary to cite a new example as rapidly as the previous one should fade out. *Pure* reason is, indeed, a myth. For no man ever learned what it meant except through illustrations, and, moreover, no one can think of it without the aid of the same illustrations by which he came to know it, that is, by means of his conditioned reflexes. And be it noticed also that the Stoics, in speaking of the "Reason" *that rules the world*, were themselves always in haste to explain the meaning of this word in terms of the physical environment.

According to this, attention is a highly unstable process. And you will perceive this to be the case if you try to keep your mind fixed upon any one of a long line of telegraph poles. The eye will, as it were, constantly desert its fixation for a near-by pole, return, desert again, and again return, or it will be found to wander up and down the pole, contemplate its crossbars, the insulators, and the wires, estimate the straightness of the pole, and so on through a score of appropriate associations until the bare pole will become sumptuously clothed with an astounding variety of meanings, all drawn from your previous acquaintance with wood, glass, metal, porcelain, geometry, mechanics, climatology, and what not.

For mind is fundamentally activity, and knows not rest. And this play of associations is simply a sign of the chemical instability of the organism, whose mind is, after all, only an instrument for the satisfaction of endless cravings in a more or less inconstant environment.

Much is said to-day about the "power of concentration," and many books are sold which purport to teach this ability. But it is too often forgotten by the authors of such books that the way to secure the continuous direction of the attention toward any one thing is first to find out to what an extent the basic interests of the individual point in that direction. For, contrary to much teaching along this line, we give our continuous and undivided attention only to those things in which we are deeply interested. This is a law of psychology and physiology, and no headway can be made against it. Hence no amount of coaxing, scolding, or other external persuasion will avail to force profitable attention in opposition to interest. As usually understood, concentration is a relatively superficial phenomenon. Its manifestations appear in the face and hands, in the postures and gestures of the external muscles; and while these can be assumed and copied for a moment by anyone, yet the attempt to train a person to concentrate by starting at this end of the mental machine is labor without either merit or results. The way to teach concentration is to find out first what the person's subconscious interests are, and whither his main energies are directed. If there are internal conflicts between his interests, or external barriers to their full manifestation, these should be taken care of first before any attempt is made to enrich and employ his associations to maintain any one fixation of his

thought. How much time is wasted in the factory, the office and the schoolroom to force attention where it simply will not go, merely because the mechanic, the clerk, and the pupil are given over to the care of persons ignorant of all psychological laws! For the accidents, the mistakes, the errors, the carelessnesses—in a word, the inattention that spoils the efforts of such persons is simply due to a sudden and subtle shift of the attention to those things which have all the while been pulling in the opposite direction. Indeed, there is no such thing as *inattention,* for we are always directing our thought *somewhere.* Inattention simply means that this direction of response is away from those things which others require us to consider. But where the factory, the office, the store, and the schoolroom become places where broad, helpful sympathies and good sentiments are manifested by all who work there—in other words, where a keen knowledge of kinetic systems and subconscious processes is found—the difficulty of obtaining and maintaining concentrated effort is reduced to a minimum. For the more we study psychology, the more do we find that the mind is not a ghost that inhabits the skull, but it is rather the whole activity of the man, and consequently any attempts to apply psychology to the solution of any special problem requires a consideration of the whole mind, not only of its conscious processes, but of its subconscious and unconscious activities as well.

CHAPTER XXIII

REASONING

IT is an ancient and honorable tradition that man is marked off from all other living creatures by his reasoning faculty. Plants and animals share with him the ability to grow and to reproduce, and the animals share with him the power to move and to feel pain, but no other living thing except man manifests that highest of all mental qualities—the power of reasoning. But just what is this power? Is it altogether novel, altogether peculiar to man, or is it rather a development of other mental qualities, the rudiments of which even the lower animals possess?

Let us first see what a variety of things the word "reason" means. To begin with, reason is commonly opposed to instinct, or contrasted with violent and impetuous emotion. The reasonable man is distinguished by deliberation rather than by impulsiveness. Instead of "dashing off madly in all directions," he ponders, compares, and measures. Again, reason has to do with such things as cause, proof, and choice. The reasonable man asks why and wherefore, and is willing to follow several alternatives before he finally decides upon any one course of action. To be sure, he may be wrong, and he may lose or fail of his purpose, but he at least attempts to profit by the successes and failures of himself and of others. And, in the third place, rea-

son is related to certainty. The man who reasons is supposed to be able to predict the future and to get at the truth of the matter he is deliberating. He says either "It is likely to happen," "It will happen," or "It must happen," accordingly as he believes more and more in the soundness of his arguments. In conclusion, then, to reason is to deliberate carefully, to find causes, and to foresee results. In thus summing up the past, and anticipating the future, reasoning is one of the most comprehensive mental activities we manifest.

Nevertheless, much that we call reason is more a matter of conjecture than it is a matter of conclusive proof. Things rarely happen precisely as we predict them. Such maxims as "You never can tell," and "Man proposes, but God disposes" have more than a superficial meaning. More often than not we claim to have predicted much more than we actually and minutely foresaw. Our subconscious desire to keep in full touch with the environment prompts us to interpret many unsuspected results as predictions of our own. We do not like to be left behind or disappointed, and hence we fill in our mental gaps with anything that comes to hand. This is not to be wondered at when we learn that Reason, far from being an immortal goddess, or a "Power that sways the world," is simply a collective name for our various individual reasons. And these various reasons the psychologist analyzes into chains of associations which are directed hither and thither by our beliefs and wishes. Every reason has a human origin and a human goal. Some of them, to be sure, are tested and true, else the gunmakers could never have encompassed the bombardment of Paris from a point seventy-five miles away. Others of our reasons are

called cogent merely because they appeal to our strongest and oldest sentiments. We feel that justice and right must finally triumph, but we are not always able to convince ourselves of the truth of this at the moment when our oil stock proves to be worthless.

Let us now consider the various stages in the reasoning process. To begin with, reasoning is usually a sign of doubt, or fear, or thwarted purpose, or lack of confidence, or some other obstacle in our minds. It is also typical of the complicated mind of the civilized man rather than the mind of the savage. The man whose wants are few has correspondingly few problems. Both the ancient Hindoos and the ancient Greeks were interested in geometry, and both drew triangles and circles to illustrate what they were talking about. But while the simple-minded Hindoos were accustomed to draw equal and similar triangles in the sand and simply say "Behold!" the more complex-minded Greeks felt it necessary to devise elaborate proofs to show that the two triangles were absolutely equal each to each. You remember the details of the process. For since two sides and the included angle of both triangles were equal, if you placed them one on top of the other, you would find a complete identity all round. Now such an elaborate proof is necessary only to convince doubters. And doubt of one sort or another is always attendant upon intelligence. The Greeks very likely knew something of visual illusions while the Hindoos just as likely did not. Consequently the Greeks realized that things are not always what they seem, and, having arrived at this stage of wisdom, elaborate proof was the only safe method to pursue. Yet since a good Greek geometer

would know at once under what conditions visual illusions were present, elaborate proofs would not be essential for his own comprehension. They were essential only to convince the doubting minds of his skeptical companions.

Reasoning, then, is the method by which we solve problems. The problems may be real, as in the case of the construction of a bridge over a roaring chasm, the discovery of a vaccine to neutralize diphtheria, or the devising of a method whereby to mortgage an automobile in order to pay for the repairs upon it. Or the problems may be unreal, that is, clear outside the range of our action, such as the habitability of Neptune or the frequency with which Julius Cæsar shaved his chin. But, in any case, we reason for the purpose of restoring our mind to equilibrium. Reasoning involves activity with a definite purpose in view. We begin to reason when, either consciously or unconsciously, we make a judgment or estimation of our predicament, after which we proceed to solve the problems that confront us by the best means we have at our disposal.

The second step in the process of reasoning is to decide upon ways and means by which to solve our problems. Suppose you return home late at night and find your house locked against you and your key missing from your pockets. You face a serious predicament—you want to get in, but you can't. You may not stop to formulate any such judgment, for your emotional disturbance may be too great to allow of any such sober rhetoric. If you were a simple-minded, fatalistic Stoic, you would simply say: "Behold! The universe is my home; I will sleep on the porch." But you are not a fatalistic Stoic; you are a mass of modern-conditioned reflexes, and

one of your sturdiest associations is: "Sleep and bed are inseparable." The very suggestion that you may have to sleep on the porch is an unforgivable insult to your inmost psyche. Your ideals forge to the front, and you demand for yourself the best the house affords, key or no key!

Here, then, begins the second stage in the reasoning process—the search for a solution to the problem that confronts you. The method is simply to bring all possible associations to bear upon the predicament. This is the work of the kinetic system. The craving for sleep, the aggravation at not having your key, your pride in your inalienable right to enter the house that belongs to you, and a host of other sentiments and emotions drive your energies through every available motor outlet you possess—in brief, you *imagine* every possible action that will result in your entering your own house. Very likely your pattern of associations is somewhat as follows: Door won't *open* . . . *open* . . . what will *open? Windows.* Has a *window* been left *open?* Which *window* was *open last?* Was it locked? Try the kitchen window. The cellar window. Can I reach an upstairs window? And so on you proceed through all the known list of openings in your house. Finally you remember that one of the windows that was hard to open was also hard to lock, and that leads you to hope that the last time it was put down it was left unfastened, and this becomes a stimulus to an elaborate climbing and pushing activity, with the final result that you get into your house, and therewith solve your problem.

And this brings us to the third stage in the reasoning process—the proof of the correctness of our inferences. The above case of proof is typical of all

scientific experimentation, and is called proof by induction. It consists in trying all ways and means by which to effect the solution of the problem involved. If our method succeeds, we call it true; if it fails, we call it false. The finding of the unlocked window and of a lever whereby to pry it up would be called a true solution to the problem confronting you when you were locked out of your own house. Had no window been left unlocked, the true solution would have been by some other method, such as by breaking a pane of glass or by crawling into the furnace through the air shaft.

The true solution, then, would depend somewhat upon the amount of damage you might be willing to inflict either upon the house or upon your clothing. If you still had to make a train that night after getting into the house, your predicament would have been even worse. For you might have both feared to break a window, thereby leaving the house exposed to pilferers, and you might also have not had the time to effect an entrance by the slower method. So that what you would have termed the true solution under one set of conditions would vary from what it might have been had you been at your entire leisure. Moreover, the extent of your patience, as well as the range of your intelligence, would determine the truth of your solution.

There are two counts on which reasoning may be called a novel mental process. The first is the extent to which our remotest associations are requisitioned in the search for a solution to our problems. The second is the great importance which we always attribute to the particular method which we have found to be satisfactory. For, while both memory and imagination depend upon association, 'yet the

need to reason our way out of a serious predicament may be said to probe the very last resources of our minds. The need to reason serves the valuable purpose not only of combining our previous associations in many new ways, but it also serves the purpose of revealing to us the unsuspected importance of half-forgotten information. Again, when we once find our way out of a predicament by the process of reasoning, we are ever thereafter wont to elevate the solution we have devised to a high place in our experience. That which for us is a true and valuable solution automatically becomes a dominating center of associations. Every possibly related thought becomes, as it were, a vassal to the "bright idea," with the result that our whole mind tends to become systematized in terms of what we have found to be true. You can test this in any evening's conversation with a group of people. Sooner or later some one will get "off his guard," and his bright ideas will reveal themselves one by one. His anecdotes and illustrations will one and all be tinged with his personal successes, and the trend of his associations hint his particular notions of truth.

The question is often asked: "Do animals think?" by which it is usually meant: "Do animals reason?" The answer to this question is the same as the answer to the inquiry: "Do *all* human beings reason?" namely, "Some do and some do not." For if by the word *reason* we mean "find a true solution to a novel problem," we are obliged to say that only a few human beings really add to the sum of human knowledge in this manner. Much, if not most, of what we call reasoning is simply remembering. It is not reasoning which leads us to come in out of the rain,

but simply the memory of a former wetting, the subsequent catching cold, and the week in bed hovering between powders and pills. The man who reasons anticipates experience; he does not merely repeat or follow an ancient adage. As few men reason, so do a few of the animals. There are horses, dogs, cats, and birds who seem to be able to calculate ways and means whereby to extricate themselves from strange predicaments by the new combination of previously acquired associations. There are also cases of trickery on the part of domestic pets, who devise subtle ways and means by which to steal and hide their pelf, and then assume disarming attitudes and postures to throw their masters off the track. In so doing they reason with a foresight and cunning which far exceeds that of many a member of the genus homo.

Modern researches into abnormal psychology have revealed to what an extent the conflict of subconscious motives distorts the workings of the reasoning process. Just as in many cases of remembering, "the wish is father to the thought," so it is with much that otherwise might pass for sound logical argument. This can be seen in all political speeches, in diplomatic transactions, in legislative assemblies where the facts under discussion are sadly warped out of their setting by violently partisan appeals, as well as in court rooms where the lawyers on one side of the case seek to convince the jury that the opposing side has completely distorted the truth. All such arguments, palpably absurd, and meant to mislead, are termed "rationalizations." The toper of other times used to "rationalize" when he gave one of his numerous reasons for taking another drink. Many people who rationalize do it without ever real-

izing how clearly they reveal their deepest motives to an onlooker. Here is a case in point: A woman whose daughter is neither young, nor harmonious in her mind, nor yet well beloved by her associates, unconsciously seeks to offset these serious shortcomings by idolizing her daughter on every occasion that is afforded. One day the daughter was out in the garden picking flowers when a humming bird, on his daily rounds, stopped and sipped one of the flowers in the garden. The bird happened to poise very near where the woman was kneeling, whereupon the mother (who was watching her through the window) exclaimed gayly to some of her associates near by: "I don't wonder the bird takes her for a flower—she's *so* sweet!"

It should not be concluded, however, that just because most rationalizing is unconscious, sound reasoning must always be a fully conscious process. By no means. For much splendid logical insight, and many a clarifying inference, comes like a flash without the least effort or perturbation on the part of the mind that achieves it. The term "intuition" is applied to such an unforeseen display of reasoning or logical ability. The "inspiration" of the inventive genius, and the "hunch" of the gambler are both examples of intuition. This mental phenomenon illustrates to a greater degree than we have yet shown how little of the thinking we do is conscious. For every intuition, like every so-called extemporaneous speech, is the conscious termination of a host of unconscious nervous and muscular processes, some of which are carried on on "low gear" for days, weeks, and even years. Our whole mental machinery may be well compared to the workings of a great lighting system whose engines, dynamos, wires, con-

duits, and switchboards are the subconscious and unconcious elements, while the incandescent light in the socket—the terminus and resultant of all this elaborate machinery—is the flash of consciousness which this elaborate machinery produces. Intuition, then, is comparable to an unusually bright gleam in the incandescent light.

CHAPTER XXIV

HABIT

THE word habit signifies any activity which has been repeated so frequently as to become automatic. We begin to form habits of action when we learn to grasp, breathe, swallow, stand, walk, feed ourselves, and become "house-broken." During the same period we are continuously acquiring habits of thought which manifest themselves in all such complex functions as attention, memory, imagination, and sentiment. To a large extent our earliest acquired habits are the basis of our personality, for with the great majority of men their later life is a set of variations on the theme established in their early youth. It was the recognition of this principle that led the poet Wordsworth to utter his famous paradox: "The child is father to the man."

Many other things than human beings, however, manifest something closely akin to habit. "Everyone knows how a garment, after having been worn a certain time, clings to the shape of the body better than when it was new; there has been a change in the tissue, and this change is a new habit of cohesion. A lock works better after being used some time; at the outset more force was required to overcome certain roughnesses in the mechanism. The overcoming of their resistance is a phenomenon of habituation. It costs less trouble to fold a paper when it has been folded already."

Thus it is not in the nervous system alone where habits are formed. A scar anywhere on the skin is a place of lowered resistance to stimulation, "more liable to be abraded, inflamed, to suffer pain and cold, than are the neighboring parts. A sprained ankle, a dislocated arm, are in danger of being sprained or dislocated again; joints that have once been attacked by rheumatism or gout, mucous membranes that have been the seat of catarrh, are with each fresh recurrence more prone to a relapse, until often the morbid state chronically substitutes itself for the sound one. And in the nervous system itself it is well known how many so-called functional diseases seem to keep themselves going simply because they happen to have once begun; and how the forcible cutting short by medicine of a few attacks is often sufficient to enable the physiological forces to get possession of the field again, and to bring the organs back to functions of health. Epilepsies, neuralgias, convulsive affections of various sorts, insomnias, are so many cases in point. And, to take what are more obviously habits, the success with which a 'weaning' treatment can often be applied to the victims of unhealthy indulgence of passion, or of mere complaining or irascible disposition, shows us how much the morbid manifestations themselves were due to the mere inertia of the nervous organs, when once launched on a false career."

The mechanism of habit formation can best be understood through a physical analogy. Just as a stream of water can be made to flow in any direction by employing suitable pressure and appropriate channels, so the various human energies involved in nervous, muscular, and glandular activity can be forced to release themselves in almost any manner desired

by supplying suitable stimuli and appropriate outlets. And just as the pipe and faucet are environmental factors which regulate how the water will flow, so the physical and social environments of the child regulate the expenditure of his energies. His father and mother, his nurse, his toys, his playground, the climate in which he is reared, and, indeed, the soft or hard quality of the floors on which he walks serve to regulate his actions in the same way as the pipe and spigot and the pressure of the water in the reservoir determine the flow of water in the tub. This is even more than an analogy, for, as it often turns out, the social factors in the child's environment are themselves as definitely fixed as are the physical features of his playground or his nursery, and the demands his elders make upon him are as precise as are those of the pipe and faucet upon the stream of water. Indeed, were not parents and teachers themselves creatures of unalterable habit, the child would hardly ever acquire any settled motor tendencies of his own. It was doubtless the recognition of these facts which led Dr. Crile to say (in the quotation we made in Chapter V.) that "environment has been the sole creator of man."

However, habits are formed not only because the same stimulus or incentive is provided day after day, but also because the responses we have once made are thereafter more easily repeated than are totally new responses. This tendency of the nervous and muscular mechanisms to "settle down" to fixed ways of acting is not a novelty in nature. The overstretched rubber band, the long wooden bookshelf constantly overloaded, and the gloves and shoes that gradually wear to the specific shape and posture of the hands and feet are all examples of the same

phenomenon. The great difference between living and nonliving matter appears in the immensely greater number of separate habits which the former can acquire, so much greater, indeed, as to make it seem at first sight that something else than nerves and muscles must be involved. But as soon as we realize how elaborate the mechanism of nerve and muscle really is, the wonder is that we do not all acquire more habits than we actually possess. The man who plays a half dozen different musical instruments illustrates only in the most rudimentary way the multiplicity of man's neuro-muscular equipments.

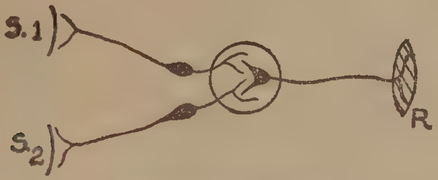
CHAIN REFLEX

The three principal mechanisms contributing to the formation of habits are the chain reflex, the conditioned reflex, and the circular reflex. Let us consider these separately.

The chain reflex is described as a series of simple reflexes, occurring one after the other, each succeeding one being aroused by the one immediately preceding it. Walking is an excellent example of the chain reflex. The sight of the floor stimulates us to put our foot forward; this action, in temporarily unbalancing us, stimulates us to put the foot down to save ourselves from falling; the touch of the floor upon the sole of the foot causes us to stiffen the leg for support; which action is immediately followed by bringing forward the other leg and foot, and so on, the movements and positions of one limb stimulating movements in the other. This is the

pattern of all habitual activity. And the more practiced the act, the more unconscious and inevitable does such a series of movements become upon the presentation of the stimulus which starts the first one going.

As an example of the operation of the conditioned reflex in habit formation, we may mention the process by which a child becomes house-broken, since it illustrates with the greatest nicety to what an extent social factors operate in our earliest habit formation. The child's natural tendency to eliminate its waste matter is, of course, not in any way checked; all that happens is that there is a novel stimulus, namely, the sight and touch of the toilet, introduced into the situation, and this stimulus gradually *conditions*, or gives the sign for, the act of elimination. "The mother starts the process of control very simply by taking the child to the toilet every two hours or oftener, and leaving it there until those acts are performed, and then bringing it back to its more customary and normal environment. The association grows up rapidly in normal children. Thereafter, the intraorganic stimulus (pressure of urine and feces) leads the child to make some sign, usually a vocal one, which stimulates the mother to gather it up and carry it to the proper place for the performance of those functions. As the child grows



CONDITIONED REFLEX

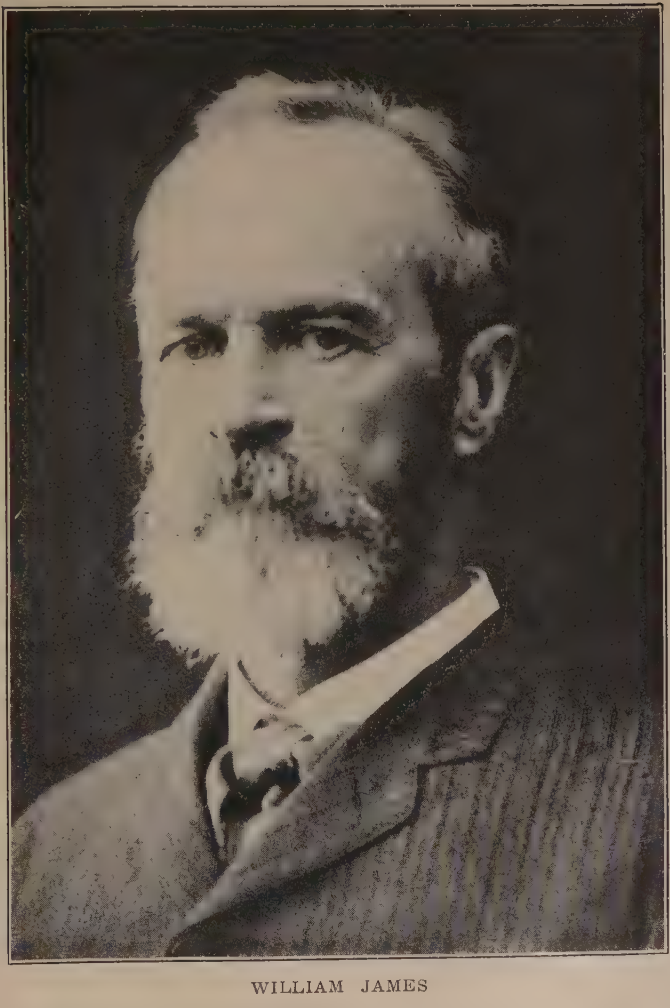
older, the pressure of such stimuli touches off the act of going to the proper place of his own accord."

All other habits which are formed at the behest or by the command of others are likewise conditioned by the word, gesture, or even presence of such people, and it is not an unusual thing to see full-grown persons perform long unused actions when suddenly confronted by some person or thing which in their early years had been the conditioning stimulus for

CIRCULAR REFLEX

the habit. Old men returning to the scenes of their childhood are often set capering with the boys of the village, thereby making a sight which might inspire an onlooker to think them temporarily gone daft.

The circular reflex has already been described as a mechanism whereby the contraction of a muscle is automatically reenforced by means of an extra nervous circuit originating in the muscle and leading again to the motor nerve which produced the original contraction. It is the constant operation of the circular reflex which makes habits of all sorts so hard to break. For it can be readily seen that if muscles in contracting automatically stimulate themselves to a greater or more prolonged contraction than the outer stimulus would by itself produce, there will be required an exceedingly strong counter-stimulus from without to eradicate the tendencies thus established. Indeed, it is doubtful whether any



WILLIAM JAMES

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ATTITUDE OF ATTENTION. A photograph of a scientist (Dr. Coblenz) whose invention measures heat of the stars.

habit, once thoroughly formed, is ever absolutely broken. It may be checked or modified, but its tendency to arise in the presence of the stimuli which conditioned it is not so easily demolished. And every such tendency (or wish) to repeat the action is itself a true physiological event, the energy for which is supplied by the most powerful and indefatigable mechanisms of the body—the organs of the kinetic system.

The practical effects of habit formation are various. In the first place, it may be observed that the more skillful we become at any game or occupation, the more are our movements simplified. The novice stumbles and makes waste motions, while the expert is at once marked by the easy, offhand manner in which he performs his habituated operations. In the second place, the more habitual our actions become, the more accurate are they likely to be. To be sure, there are people who, in playing on the piano or in the tennis court, always hit the note or the ball in the same erroneous manner, but such people are happily in the minority; the usual effect of practice, while not producing perfection, is to produce a much more satisfactory result than is ever attained without such practice. Beginner's luck is the one notable exception to this. A third practical effect of habit is to diminish fatigue. The novice in the factory is ready to drop with weariness at the end of the day, albeit he has produced far less than the older hands, while as his skill increases and his actions become more and more habitual, his energies are more carefully conserved and more evenly expended. When such is the case, he is said to be "adapted" to his work.

Habit also "diminishes the conscious attention

with which our acts are performed. Whilst we are learning to walk, to ride, to swim, skate, fence, write, play, or sing we interrupt ourselves at every step by unnecessary movements and false notes. When we are proficient, on the contrary, the results follow not only with the very minimum of muscular action requisite to bring them forth, but they follow from a single instantaneous 'cue.' The marksman sees the bird, and, before he knows it, he has aimed and shot. A gleam in his adversary's eye, a momentary pressure from his rapier, and the fencer finds that he has instantly made the right parry and return. A glance at the musical hieroglyphics, and the pianist's fingers have rippled through a shower of notes. And not only is it the right thing at the right time that we thus involuntarily do, but the wrong thing also, if it be a habitual thing. Who is there that has never wound up his watch on taking off his waistcoat in the daytime, or taken his latchkey out on arriving at the doorstep of a friend? Persons in going to their bedrooms to dress for dinner have been known to take off one garment after another and finally to get into bed, merely because that was the habitual issue of the first few movements when performed at a later hour. We all have a definite routine manner of performing certain daily offices connected with the toilet, with the opening and shutting of familiar cupboards, and the like. But our higher thought centers know hardly anything about the matter. Few men can tell offhand which sock, shoe, or trouser's leg they put on first. They must first mentally rehearse the act; and even that is often insufficient—the act must be *performed*. So of the questions. Which valve of the shutters opens first? Which way does my door

swing? etc. I cannot tell the answer; yet my *hand* never makes a mistake. No one can *describe* the order in which he brushes his hair or teeth; yet it is likely that the order is a pretty fixed one in all of us."

The psychology of habit has intimate relations with all our life activities. Education, custom, tradition, morale, and countless other things are dependent for their value and stability upon the fact that human beings all acquire fixed and unalterable patterns of behavior. "Riderless cavalry horses, at many a battle, have been seen to come together and go through their customary evolutions at the sound of the bugle call. Men grown old in prison have asked to be readmitted after being once set free. In a railroad accident a menagerie tiger, whose cage had broken open, is said to have emerged, but presently crept back again, as if too much bewildered by his new responsibilities, so that he was without difficulty secured."

William James in writing of the ethical and pedagogical importance of habit, thus sums up his conclusions in language both clear and forcible, even if perhaps not quite in keeping with our present ideas of social democracy:

"Habit is thus the enormous flywheel of society, its most precious conservative agent. It alone is what keeps us all within the bounds of ordinance, and saves the children of fortune from the envious uprisings of the poor. It alone prevents the hardest and most repulsive walks of life from being deserted by those brought up to tread therein. It keeps the fisherman and the deck hand at sea through the winter; it holds the miner in his darkness, and nails the countryman to his log cabin and his lonely farm through all the months of snow; it protects us from

invasion by the natives of the desert and the frozen zone. It dooms us all to fight out the battle of life upon the lines of our nurture or our early choice, and to make the best of a pursuit that disagrees, because there is no other for which we are fitted, and it is too late to begin again. It keeps different social strata from mixing. Already at the age of twenty-five you see the professional mannerism settling down on the young commercial traveler, on the young doctor, on the young counselor at law. You see the little lines of cleavage running through the character, the tricks of the shop, in a word, from which the man can by and by no more escape than his coat sleeve can suddenly fall into a new set of folds. On the whole, it is best he should not escape. It is well for the world that in most of us, by the age of thirty, the character has set like plaster, and will never soften again."

Applied psychology is concerned with both the making and the breaking of habits. Of these two, the latter course offers the greater difficulties. The following maxims, quoted from James, are of especial value in this connection. "In the acquisition of a new habit, or the leaving off of an old one, we must take care to *launch ourselves with as strong and decided an initiative as possible.* Accumulate all the possible circumstances which shall reenforce the right motives; put yourself assiduously in conditions that encourage the new way; make engagements incompatible with the old; take a public pledge, if the case allows; in short, envelop your resolution with every aid you know. This will give your beginning such a momentum that the temptation to break down will not occur as soon as it otherwise might; and every day during which a breakdown is

postponed adds to the chances of its not occurring at all."

A second maxim, based solidly upon physiological principles is: *"Never suffer an exception to occur until the new habit is securely rooted in your life.* Each lapse is like the letting fall of a ball of string which one is carefully winding up; a single slip undoes more than a great many turns will wind again. *Continuity* of training is the great means of making the nervous system act infallibly right."

It is essential, however, that we understand just what it means to "suffer an exception" in physiological terms. For every exception that is allowed reveals the secret wish to return to the old habit—it means that some part of our personality desired the exception to occur. And such a wish is really nervous and muscular energy whose release has been conditioned by a stimulus either in the outer environment or within the body. Hence the wiser teaching is either to remove oneself from any environment or person who elicits the habitual reaction, rather than to grit one's teeth in an effort to call upon his "will power." Dogged effort is not necessarily wise; it may, indeed, be wasteful or harmful. Herein lies the value of Ostwald's Imperative of Energetics: *"Waste not free energy; treasure it and make the best use of it."* For the man who is not frank and bold enough to give up even that family or acquaintance who has become the conditioning stimulus for a habit that lessens his good can scarcely hope to succeed in developing his best traits to their maximum perfection. As valuable as a reasonable amount of "self-control" may be, in comparison to a sagacious control of the environment it pales into insignificance.

And now a final gleam from physiology upon the problem of remodeling and effacing injurious habits. It is well known that we cannot exactly duplicate any action we perform. Draw a line, and, using that as a model, attempt, if you will, to repeat it precisely. Even use a ruler, if necessary, and carefully measure the results. You will find that you have in all cases unconsciously made minute changes with every repetition. Or, attempt to duplicate the note you sing, or the impression of your thumb on wax, and the same inequalities will at once appear. Now what does this mean in terms of the neuromuscular mechanism? The meaning is that no action we perform, either voluntary or involuntary, ever uses exactly the same nerve or muscle fibers twice in succession. In other words, the neuromuscular mechanism is constantly changing the emphasis of its responses, now using one group of fibers, again a slightly different one, and so on, as long as the action is repeated.

The application of this to the problem of eradicating or remodeling habits is at once clear. For since in the repetition of a habitual act the nerves and muscles are constantly *"shifting their load"* (just as a man carrying a heavy log of wood on his shoulder ever changes it about to new positions), it is perfectly possible to make larger and larger variations in this shifting, provided the proper stimulus and the requisite aids from other muscles are provided. For the bodily mechanisms, in thus relieving themselves of their load of work, are, figuratively speaking, desirous of a change of activity. And there is no doubt that all the subconscious influences for the modification or eradication of habit can be traced to this very condition.

CHAPTER XXV

WILL

NO mental activity has such an important relation to the larger affairs of life as has the function of will or volition. Its importance is felt at once in the law courts, where the question perennially arises as to whether the defendant willed or intended the fraud or murder of which he is accused. "Was it voluntary or accidental?" On this the whole case and decision depend. Voluntary actions are also contrasted with those which are committed under the command and threat of another, and again in such a case the judgment of guilt depends upon the degree to which external force was the deciding factor. Again, in popular speech human will is opposed to necessity, or fate, or to the "will of God," though often the fatalist and stoic are somewhat in doubt as to where the dividing line between human and superhuman wills is to be drawn. Moreover, volition is set over against instinct, in that the former is supposed to be acquired, while the latter is regarded as an inborn trait, for which little blame and less credit is to be expected. In all such cases will or volition is regarded principally as a force causing the action, without respect to any other important factors involved. We get at one of those factors when we reflect that will is often identical with *deliberation leading to resolution.* The irresolute man is regarded as having lost

his will. Every idea he entertains fails to mature into action; he cannot decide between going and staying, marrying and remaining a bachelor, or between having toast or muffins. And still another important factor of volition appears in the distinction we draw between the firm and continuous perseverance of one man and the weak, spineless backsliding of another. Will here means actions that "follow up" and complete the plans already outlined and deliberately chosen. It may be observed also that the maxims we gave in the last chapter for the making and breaking of habits were a fitting introduction to a discussion of the will.

Let us see, then, out of what various factors a voluntary action is made. In the first place, will means *choice*. It is not a voluntary action which marks the soldier who, at the command of his superior officer, plunges with fixed bayonet "over the top." It may be a brave action and a laudable one, but it is not therefore a voluntary action. The soldier has, to a large extent, lost his power to choose what he will or will not do under such circumstances. Discipline has made him a machine, and camp and trench life have made him unutterably bored; hence, the command to charge, while affording a welcome release to his energies, is not an example of voluntary action, since the power to choose is denied him. The officer does not say: "Bill, there are several things you might care to do this morning: remain here, go back to the reserves, or charge over the top. If any one of these appeals to you, let me know." Indeed, he does not. Bill is treated either as baggage, or as a unit of velocity and momentum—everything he does is the result of a command impinging on him from without. His choices are reserved for

the days on which he has leave of absence from the line of fire.

The soldier is, however, not the only example we might have cited of the lack of will through the inability to choose. For since choice is in many ways opposed to habit, the man whose life is spent in dull routine, day after day the same, and year after year without interruptions, becomes after a while as helpless and as lacking in the power to will as is the soldier. You see this decay of mental power in the person who always walks to work along the same street, albeit a dozen different routes are open to him. You see it at the breakfast table where, in spite of the admitted monotony of the meal, the same food cooked in the same way invariably appears. You see it in the summer vacationist who packs off for the same place year after year, even though he has gotten stale on it. You see it also in the postures, facial expressions, and gait of the majority of mature persons who manifest by their dull uniformity of life that their powers of choice have long since died. This being so, volition becomes a very rare phenomenon. For if few can still choose, few have will. And since a very small percentage of people really *do* alter their habits and face situations freshly, we may conclude safely enough that volition, like reasoning, is a rare thing to find.

The importance of choice as an element of volition is further emphasized when we inquire into just what it means to choose. For the basis of choice is sentiment, taken in its broadest sense, and sentiment, as we have already had occasion to learn, is a function of that greatest going concern of the whole body—the kinetic system. To put it more simply, choice implies a freedom of wishes; it means

that we are not bound by either habit, custom, or fear, but can face things with a fresh mind. It means that we have not become so inert and muscle-bound that we have no energy left wherewith to respond to a new stimulus in a new way. It means that we have not suppressed all our deeper desires so thoroughly as to be inflexible and unresilient when an occasion is offered to reveal and release those desires in overt action. Indeed, to have the power of choice means more than this—it means that we are still able to learn something new, and still young enough in temper to try new methods when the old methods fail to produce satisfactory results. Briefly, the power of choice and the exercise of that power are infallible signs of intellectual health, just as their absence always denotes intellectual decay.

Even more than this, however, remains to be said about the physiological basis of choice. For the bodily mechanisms of locomotion and action are one and all so constituted as to favor, nay, to require the continuous exercise of the function of choosing. Think, if you will, just what is implied by the fact that almost every moving member of the body is supplied with *two* sets of muscles—the flexors and the extensors. Is not the power of choice almost guaranteed by such a twofold pattern of structure? For through the possession of these flexors and extensors we can walk *forward* or *back, reach out and take* or *refuse and push away, nod* or *shake* the head, *smile* or *frown*, and perform a thousand other similar *pairs* of actions. And all this simply because we have *pairs of antagonistic muscles.* But more than this is implied by the mechanical structure of our bodies. For be it noted that almost all our adjectives and adverbs, and our judgments of worth and

value come in *pairs*. *Good* and *bad, high* and *low, beautiful* and *ugly, war* and *peace, attraction* and *repulsion, freedom* and *necessity, resolute* and *irresolute,* and a vast horde of other such sets of terms get their antagonistic meaning from the fact that they imply and provoke in us antagonistic responses on the part of our flexor and extensor muscles. Indeed, the origin of such terms is due to the muscular architecture of the human body. Choice, then, as we have analyzed it, means the power to employ either set of such opposed muscles with equal ease and vigor. The "slave of habit," in using always the same muscles, literally discards the use of half of his body. He is like the man who never takes exercise, and goes through life without knowing what neglected supplies of health and resilience he is carrying under his skin.

Let us now briefly consider one other important factor in volition. For besides involving choice, will implies skill, or the ability to carry out the action contemplated and attain the object desired. Since man has not the skill to fly by his own efforts, it is impossible for him to will such an action. On the other hand, a man may, after he has studied and trained for it, voluntarily perform any such action as setting a broken bone, papering a room, or planning a battle. Our voluntary actions are, then, limited by our skill. No more can we perform the impossible than we can do that for which we have neither aptitude nor training.

Nevertheless, it often comes about that in the midst of danger and in the presence of situations that demand heroic measures, there are very sudden connections established between our various abilities which enable us to perform feats impos-

sible at any other time. At great conflagrations, or at threatened drownings, or at any other times when much is at stake, an unsuspected increase of ability and strength is often displayed. This, however, is not strange when we consider how little of our stored energy is used in the ordinary pursuits of life. The amount is certainly less than 25 per cent. It is only when we are under some emotional strain, or must sink or swim, that anything like the full quota of our energy reserves are placed at our disposal by the kinetic system. And even then the limit is by no means reached. That is seen only in the case of the maniac, who, slight of build though he be, yet requires three or four stalwart nurses to subdue him.

Volition does not mean violence. It rather means continuity of action and coordination and control of motor energy. Violence and precipitation are signs of an unhealthy will. Particularly does continuity of action once begun mark the man of healthy volitions. "The man of strong will is one whose tendencies are so deep-seated and persistent that he attains his end or, at any rate, continues to strive toward it, however remote it may be and however numerous the countersuggestions that oppose it; and the man of weak will is one whose tendencies are so unstable that he is at the mercy of every fresh suggestion that comes." James remarks that when the will is healthy, action follows, neither too slowly nor too rapidly, as the resultant of all the forces engaged; whereas, when it is unhealthy, action is either explosive or obstructed; the mercurial or dare-devil temperament shows an explosive will, "discharging so promptly into movements that inhibitions get no time to arise"; and the limp characters,

the failures, sentimentalists, drunkards, schemers, show the obstructed will, in which "impulsion is insufficient or inhibition in excess."

From all this it can be readily seen that volition involves no factors or forces except those we have already considered in connection with other bodily activities. Will is a kind of human action—action as the result of choice, and involving skill, coordination, and control. And if it be asked, What does the controlling? the answer is that it comes from two sources: (1) From the environment and (2) from our kinæsthetic sensations. You prepare to "place" a tennis ball out of the reach of your opponent. What determines the quality and quantity of your stroke? The position of your opponent in his court and the "feel" of your racquet in your uplifted hand. In other words, the environment and the kinæsthetic sensations. No other sources of control are either possible or effective, whether in tennis or in any other situation in which action is called forth from us. These are our only cues, no matter what activity we may be engaged in, nor how significant are its results. We take our cues for both the beginning and the continuance of action from the effects of such action on the environment and upon ourselves.

The psychologist is often confronted by the problem of building up or restoring a broken-down will. This defect is by no means easy to remedy, for the reason that it often requires the most careful analysis to reveal the causes of this defect, and the most assiduous application of the treatment to produce the desired result. Loss of will is by no means as easy to cure as the advertisements in the magazines describing books on "Will Power" would lead one to believe. The loss of the power to choose, and of

the power to coordinate and control action, is much more than skin-deep; indeed it affects the whole kinetic system. Usually, also, the patient is uneasy lest the true cause of the disorder should be found out. Sometimes, of course, it is impossible to discover it, but very often it turns out to be some fear or some unpleasant experience which has been smoldering silently away for long years, without ever getting expression, and which all the while has been undermining the whole response mechanism. Sometimes the person thus affected is impossible to aid; every suggestion, every encouragement, every chance that is afforded for him to make a choice is received with apathy. In such cases the wisest method becomes also the kindest, though often the wisest method looks rough and unfeeling to an onlooker. "Strong-arm" treatment, however, is in many cases the only thing left to be undertaken. Burning down the bed of a pretending paralytic is not a criminal procedure.

One reason why so few people manifest a full-grown, healthy will in middle life is that in their childhood and youth they were thwarted in almost every choice they undertook to make. And of course, in families where children are treated as so much baggage, or where despotism rather than co-operation is the rule, one cannot expect that volitions will be either welcomed or encouraged. On the other hand, whenever a child is taught to solve his own problems through his own ingenuity, and stimulated to form habits of self-reliance, much can be expected of him when he grows to manhood. The education of boys has always been superior to that of girls in this respect, since girls are more hedged about and sheltered than are boys, and are given

less opportunity to develop individuality and resourcefulness. A boy will play with men, share in their banter, and join in their work; it is still preposterous that a girl should attempt to piece out her education by any such bold undertakings. Nevertheless, it is equally preposterous to hope that the ability to choose and carry out a course of action can come by any other means than the trial-and-error method. To be known, the environment must be experimented with, and to be experimented with it must be met frankly and frequently. The will can be trained like any other human activity, and it *must* be trained if it is to function effectively in the difficult concerns of life.

CHAPTER XXVI

FATIGUE

WE call this an age of labor-saving machinery. But did it ever occur to you how many things the expression "labor saving" really means? The printing press which reels off thousands of newspapers every hour, the gang saw that cuts out a dozen two-by-fours at one clip, and the drilling machine that bores twenty holes of different sizes and depths in the same piece of steel with one motion of the operating lever is actually saving three things —time, space, and that most important of precious things, human effort. For even if it were possible for a dozen men to squeeze into the saw pit, they could not possibly rip out the lumber as fast as the automatic machine now does it, nor could they ever hope to finish the job with less than a thousand times the loss of human energy that it now requires. It would be likewise futile on these three counts to compete with the printing press or the automatic multiple drilling machine. And yet, in spite of the fact that inventors have given us so many effort-saving devices, fatigue is still a daily occurrence with most of us. Or, if not fatigue, at least a "tired feeling," or "boredom," or "monotony," or a general "weariness of the flesh," all of which seem at times so much like true fatigue that they are often mistaken for it.

Fatigue is the overdraft on the bank of human

energy. It is the condition that comes about when the body is using up its reserves of energy faster than they are being restored. Two kinds of activity produce this condition—physical work and mental work. The farmer, the foundry helper, and the Marathon runner are examples of those whose fatigue is brought on by physical work, while the bookkeeper, the piano tuner, and the student cramming for an examination illustrate the case of mental fatigue. Perhaps we should not really say "mental" fatigue, but rather fatigue of some special sense organ, such as the eye, the ear, the tongue, and so on. For every case of so-called mental fatigue is caused by overworking some such part of the body. To be sure, the two kinds of fatigue may combine, as in the case of a man carrying a heavy suit case hurrying to make a train and threading his way about in the dark through the crowded traffic along unfamiliar streets. Usually, however, only one kind is present at a time. Whatever else we experience is some emotional disturbance, such as boredom, aggravation, or monotony, which we shall talk about in connection with fatigue a little later.

Not only can we be fatigued *by* either mental or physical work, but we may be thereafter fatigued *for* either mental or physical work. Usually the same kind of work that tires us is the kind we are thereafter unfitted to perform. Herein lies the whole point of the psychology of recreation. One kind of work fatigues a certain part of the body, but leaves the rest of the body (or at least a certain few of the muscles) fresh and ready for other activities. Since much fatigue is *local* we may become recreated in the tired part by merely a change of effort. Still more fatigue comes on because one set of mus-

cles (as in the arms, the legs, or the face) has been used in one way so long as to produce a condition very much like cramp. This we shall call *occupational* fatigue. The word is not quite pat, for fatigue is often induced by lying in bed or loafing, neither of which are exactly occupations. Be that as it may, every bodily posture or kind of activity, if too long maintained, uses up energy at an ever-increasing rate. So it is that after a morning's typewriting we are more than ready for another kind of work, even though it be more arduous; just as after a busy vacation in the country or at the seashore, we are glad to get back home and settle down again to our regular occupation. Many people show much natural psychological talent in reducing their own fatigue. Frequently it is the rule in business offices for a man to do both inside and outside work each day so as to keep his pep for both kinds; in the schoolroom the classes are many and short, and the work varies as much as possible from hour to hour; while many a housewife shows her intuition of the laws of physiology by distributing her spring and fall cleaning over a period of two or three weeks.

Suppose we now ask the questions: What actually happens in the body to produce the state or condition we call fatigue? Where does this loss of energy take place? and How is this loss registered? In the first place, we must remember that all activity involves a slow combustion or burning process in the body, the oxygen for this combination being supplied by the air we breathe. More oxygen is taken from the air by the lungs in all kinds of exertion, and more carbon dioxide is given out than during rest. "A man gives out more than three and one-half times

as much carbon dioxide per minute while walking at the rate of two miles an hour as when asleep. If his pace is quickened to three miles an hour, he discharges more than five times as much, and when working in a treadmill nine times as much is given out as when asleep." All of the carbon which is thus consumed comes from the body. In endurance tests the amount is often so great as to show several pounds loss of weight in the athlete. Not all of the carbon dioxide produced during work is eliminated by the lungs, but some of it remains in the system. Besides, muscular action produces lactic acid in the muscles, which impedes further activity there. These two chemicals—carbon dioxide and lactic acid—are called fatigue products or fatigue substances. They are both derived from the carbohydrates we eat, such as the sugars and starches of fruits and vegetables, which are the quick fuels or kindling of the body. Two causes, then, of fatigue, are manifest. One is the burning up or actual loss of the body's substance; the other is the presence of fatigue products generated too rapidly to be thrown off by the lungs or by the organs of excretion. Breathe and sweat as we may—the former for the purpose of taking in fresh supplies of oxygen, the latter to eliminate the fatigue products—we are quite unable during the severest muscular exertion to restore the body's energy to normal. That such fatigue substances are detrimental to effort has been shown by injecting dilute lactic acid into a fresh frog's muscle. The muscle immediately shows great loss of the power of contraction. Washing this poison out again with a salt solution restores the same muscle to its original freshness. With the lighter forms of work and exercise, carbon dioxide alone seems

to be present, while in our more violent efforts lactic acid begins to be produced.

Not only in the muscles, however, do we find the conditions which make for fatigue. "Glands in fatigue seem to secrete less than when fresh, and it may be that the action of digestive juices is diminished. A fatigued heart is dilated, its beats are quickened and may become irregular, and its resting period may become abbreviated." In addition, "when work is continued beyond the fatigue point, the nervous system performs its part with a more intense and wasteful expenditure." Indeed, the irritation that accompanies fatigue leads to a breaking down of nervous structure." Overwork thus tends not only to destroy muscle substance, check the freedom of glandular action, hurry and disorder the heartbeat, but also threatens the integrity of the nervous system. For the fatigue products which the system cannot throw off enter the blood stream and thence are distributed to all the structures and organs of the body. It is because of this wide and sudden distribution of fatigue poisons that we breathe faster and sweat freely when we are physically tired. These are the body's own desperate measures whereby to take in more oxygen and eliminate more waste than usual. The breathing is accelerated because some of the fatigue poisons have been carried by the blood to the upper part of the spinal cord, or medulla, where they overstimulate the nervous center for respiration.

The body has one or two other handy little automatic devices whereby to offset its fatigue. One of them is most curious. The presence of a small amount of lactic acid acts as an irritant, and stimulates the whole body to a spurt, or greater speed of

INTENSE FATIGUE. At the left is the runner Kohlemainen as he appeared when fresh, before beginning a race. The effects of exhaustion are evident in the picture of the same athlete when leaving the grounds after winning a race.

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DETERMINATION AND PHYSICAL EFFORT. The violent effort of the runner just before breaking the tape in the moment of victory is evident in his face.

activity. One is tempted to say that this is a device for urging us to hurry and finish the work in hand before we are all tired out. This small amount of poison, indeed, makes us appear and feel quite vigorous and full of "pep." We rarely take it as a sign that we are soon to decrease rapidly the output and quality of our work. Children often show this same sudden increase of activity, and for the same reason. Even after a long day of play they still want to romp and tumble, and, except for their flushed faces and dry lips and, perhaps, a general irritability of temper, give no evidence of the onset of exhaustion. Another automatic device which prevents the fatigue from spreading until it is noticeable is the production of *adrenalin*. If this substance is injected into a tired muscle brought to rest, it requires only a matter of five minutes for it to produce a beneficial effect. Without adrenalin, that is, with rest alone, it might require fifteen minutes to two hours to restore the muscle to its original and continued vigor of action. Now this adrenalin is a substance which two glands, one near each of the kidneys (called the supra-renal capsules), supply to the body through the blood stream. A very important nerve of the body, the *splanchnic* nerve, when stimulated, increases the amount of adrenalin secreted by these glands. It is entirely possible that the fatigue poisons themselves, through being carried by the blood to the spinal cord, can effect such a stimulation of the splanchnic nerve, which in turn reduces the fatigue which has caused its own stimulation. All these automatic devices for eliminating fatigue are indeed marvelous.

We must not, however, make the mistake of locating the cause of fatigue solely in the muscles. For

it seems that muscle substance by itself is practically indefatigable. Although it is true that the muscle begins the fatigue, as we have just indicated by showing that poisons accumulate there, yet muscle alone could not produce exhaustion. It is apparently in the nervous system that the real blockades take place. In the most extreme forms of exhaustion the nerve-cell body shows signs of shrinkage and deterioration, while in the milder forms the junctions between the nerves (the synapses), and the junction of nerve and muscle (the end plates), appear to be the points where the impulses are retarded and aborted. In a sense, then, the severer forms of fatigue are never local; they involve the whole body more or less, including muscle, gland, blood and nerve; and they affect the breathing, the digestive processes, and the elimination.

As we have already hinted, fatigue reduces both the amount and the quality of the output of work. More errors are made, worse errors are made, and a greater variety of errors are committed during fatigue than during any other period, even including the period of learning in a skilled occupation. With errors come also accidents, the number of which is often increased because the worker who is paid by the piece hurries to retrieve his mistake only to injure himself in his machine. And this leads us directly to the question of emotional excitement in its relation to fatigue, which we shall at once consider.

It is a common experience that work in enjoyable surroundings, with pleasant companions, under the stimulation of rivalry and cooperation, with a substantial reward at the end of it, and at a rate that does not make occasional speeding up impossible,

does not fatigue one nearly as soon as does work of an entirely different character. It matters immensely whether there is an outstanding enjoyable feature about the tasks we perform, and this difference is not merely in how we feel and look, but also in the amount of fatigue poisons which are accumulated and dumped back into the system. Galton says that a man with no interest is rapidly fagged. For, even though prisoners are well nourished and cared for, they cannot perform the task of an ill-fed and ill-housed laborer who enjoys his work. "Whenever they are forced to do more than their usual small amount, they show all the symptoms of being overtaxed, and sicken. An army in retreat suffers in every way, while one in advance, being full of hope, may perform prodigious feats." It is customary to speak of these emotional spurs and drags as "mental." Especially often does the expression, "I was mentally tired," mean little more than an emotional repugnance to the idea of doing more work. Likewise, "boredom," "ennui," and "monotony" refer not so much to the effort required to perform work as to the resistance to be overcome in starting the human machine. Now this emotional repugnance or resistance is, while it lasts, very real. And it is just as much an example of the display of physical energy as is the activity which it blockades. It is maintained, just as is that activity which is hindered, by the joint action of nerve, muscle, and gland, being none the less physical because it seems to have no particular location in the body. When, then, we become bored with our work we are really diminishing the energy we formerly expended upon it, or at the very least hindering the freedom of action which we formerly manifested.

At once, of course, this opposition of forces shows in our reduced output of work and in our subsequent feeling and attitude. For this boredom which is at bottom a pulling in two directions—one toward the work and the other away from it—involves a division of our personality which reveals itself in many ways. Our faces often look empty, dark, and even tragic. Resentment shows about the mouth and eyes, and the flexibility and poise we might have achieved fail us altogether.

The relation between fatigue and the whole field of applied psychology should at once be apparent. For while all work whatsoever must be accompanied by a loss of energy, it does not follow that all kinds of work will equally tire us. And even though fatigue is in some ways a blessing, since it prevents us from draining our physical resources to the last drop, yet boredom and emotional depression are never happy symptoms. Hence we may lay it down as a first principle in applied psychology that the choice of work is of cardinal importance in the reduction of fatigue. The vocation a young man selects means much more than the financial returns; it means returns in the shape of emotional spurs just as much as it means dollars and cents. Carlyle meant just this when he said: "Blessed is the man who has found his work!" This does not imply necessarily that enjoyable work is always light or easy work, for there are very few emotionally contented men who are holding down "soft snaps"; but it much rather means such work as thoroughly employs a man's abilities and his preferences, his muscle as well as his ambition. Needless to say, all vocational guidance and employment psychology have their roots in this principle.

Fatigue may also be greatly reduced by regulating the rate at which work is done. Not every hour of the day is the rate of the flow of human energy the same; between 10 and 11 a. m., and between 2 and 3 p. m., the motors of the body are readier to go on "high gear" than at any other time. The wise begin work by warming up to it, not by "dashing off madly in all directions." In many a factory these physiological principles are well understood, and the rate of work is carefully ordered to suit the human factor.

Another great help in the reduction of fatigue is the elimination of needless distractions. Too many factories, stores, and business offices are far more disorderly and noisy than they need to be or than is compatible with the greatest business efficiency and emotional health. The nagging school-teacher, contentious and irritable table companions, idle and fruitless political arguments all produce an emotional turmoil against which honest work can make no headway. The distracting influence of direct lighting has long been known, and it is conceivable that many other now unsuspected features of the environment will eventually be examined with a view to discovering their contribution to fatigue.

The mental set or attitude with which work is approached has much to do with the elimination of both fatigue and boredom. Many tasks, of course, are unpleasant because they do not give sufficient free play to our energies, or because, when we are ready for the work, the work is not ready for us, but very often what we call monotonous work is simply a uniformity and repetition which we have come to hate. If, therefore, we approach even the most monotonous kinds of work with the attitude

which, if put into words, would read: "This is a long job, and some say it is tiresome, but I reserve the right to feel tired out only on things which I like to do," a much better day will ensue than if the work be approached with an attitude of sourness accompanied by premature sighs. Self-encouragement is, indeed, one of the most valuable and potent forces in all human affairs. When put into words it is called *positive autosuggestion*, and, as may be readily guessed, it has played a tremendous part in the whole history of civilization.

Fatigue and food have a permanent relationship to one another. The first materials of the body to be consumed during exertion are the carbohydrates. A quick fuel may, therefore, be provided by such foods as sugar, chocolate, or raisins, since it is out of such things that muscular energy is directly made. But, besides this quick fuel or kindling, the body needs building material or protein in the shape of the common stable articles of the dinner table, such as cereals, meats, fish, milk, and eggs. These furnish the reserves of energy with which continuous efforts are maintained. After violent exertion drinking hot water serves the purpose of flushing the system of the fatigue poisons it has accumulated. Even quite as important for many people is the matter of overeating or undereating. If a man rushes to and from his meals without allowing sufficient time for the digestive processes to start properly or to gain a good momentum, he is bound to suffer sooner or later from malnutrition. Or, if he is so overstimulated by fatigue as not to feel hungry, he may eat delicacies to please his palate rather than stable nourishment to refill his depleted reservoirs. All such unwise actions prevent our food from serv-

ing the purpose of restoring both body and mind to their normal conditions.

Just as proper nourishment is essential in the reduction of fatigue, so also is proper care of the body. Comfortable and hygienic working clothes should be well-fitting but loose, allowing both freedom of breathing and freedom of motion. In a word, they should be entirely unnoticeable to the wearer. The kind of clothes in which children play and romp are ideal working clothes for the adult. The working shoe is equally important, especially for those who have to stand during the working hours. Since one kind of shoe is best for standing, another for walking, and still another for lounging, the wise man will give some study to the anatomy of his feet in order to be always comfortable and at ease. A change of shoes is really a change of work, for no two shoes press upon exactly the same parts of the feet or employ exactly the same muscle fibers. Since much fatigue is due to unsuspected troubles in the eyes and the teeth, these parts of the body can hardly get too much attention from the average person. But while the eyes usually register their complaints by means of headache, eye-strain, and watering, the teeth may be all the while contributing poison to the system without giving any but the slightest warning of their condition. Besides, no amount of sleep, rest, or recreation can efface such fatigue as diseased teeth produce. In such a man the death process is ever at work. Whether he wake or sleep, be joyous or gloomy, and in spite of all the autosuggestion he may use, the poisons are ever increasing in his blood. Many irritable and habitually tired people have been made so and are kept so through no other cause than this.

And lastly, though not any the less in importance than the foregoing, change of work or avocational interest, and the judicious use of exercise to keep fit must not be omitted from this consideration. For most of the boredom and monotony we experience is due either to our having lost interest in the game of healthy living or else to our existing solely on the margin of energy which the day's food supplies or the day's obligations call forth. And so it is quite plain that fatigue depends as much on a man's prudence and morale as on any other factors. And while there will perhaps always be the plowman who "homeward plods his weary way," and "tired eyelids upon tired eyes," it is just as certain that the problem of fatigue will be solved by nothing other than the wise application of psychology to all the conditions which make work and life what they can be at their best.

CHAPTER XXVII

SLEEP

"WE all love life; and we all wish to live as long as possible; yet the third part of our lives, and sometimes even the half, we give up to sleep." Until the year 1850 almost no attention whatever had been given to the scientific study of this curious and important phenomenon of the life of all animate beings, both plants and animals. It seems as if man had deemed the occupations of his waking life to be far too urgent to allow for any particular study of the nature of his rest; or else the means for analyzing the numerous factors of slumber were altogether wanting to him. To the primitive man "Sleep, Death's twin brother" must have appeared as one of the most mysterious of all the changes which nature wrought upon him; certainly we know that many of his beliefs and traditions originated in the inferences he drew from the postures and dreams of sleeping men. To-day, however, with the advance of scientific insight, we are able to come at the physiological facts of sleep in an unusually direct manner. Besides, our increasing interest in the utility of all such facts for the betterment of life enables us to employ this knowledge more advantageously than if the nature of sleep were yet entirely unknown.

Sleep is an instinct—the instinct for periodic rest. Would it be too surprising if we were to add that the

nature of sleep is chiefly to be understood by calling it *a function of the sun?* For sleep normally comes at night, and at night the sun is gone, depriving us of the light whereby the world is illuminated. Our pathway is no longer lit, and the eye no longer stimulated. Now the eye is the chief organ of our active and conscious life, the dominant guide and director of all our behavior. It was the light of day that roused us in the morning, and the same light directed us hither and yon during the morning and afternoon. And now that the light, the stimulus to vision, the chief natural aid to activity is gone, is it any wonder that the eyelids close when that which alone lifted and kept them open has ceased to stimulate? For just as human activity is the physiological effect of daylight, so is sleep the physiological effect of darkness. Sleep, then, as we have said, is originally a function of the sun.

Mere darkness, however, is not the only factor in producing sleep. The day's activities—work and the errors it entails, ambition and the failures it occasions, and the fatigue which both work and ambition generate—wear down the body's reserve supplies of energy so that rest and sleep become both sought for and demanded. The eyes, furthermore, in addition to their being delicate organs affected by light and darkness, are the most active machines we have for exploring the visible environment. Their muscles likewise fatigue and become inert, and such fatigue and inertness spread to the whole muscular apparatus of skill and locomotion. But all these conditions, rest-provoking though they be, could not of themselves be called the stimulus to sleep. For the whole body, more or less—brain, blood, respiration mechanism, and skin—all contribute their share of

needful changes. Let us see what these many and curious variations are.

"When we fall asleep the eyelids are lowered over the eyeballs, which turn upward, and the voluntary muscles are relaxed, so that the whole body, and especially the face, presents a picture of complete repose. At the same time, the respiration is more or less modified; it becomes slower, and the amount of inspired air is considerably diminished, so that instead of seven liters a sleeping man often inspires only one liter. The respiratory act also changes its character; while during the waking state abdominal respiration usually predominates in man, during sleep thoracic or costal respiration predominates. Sleep produces a weakening of the action of the diaphragm; at the same time inspiration is more prolonged than during the waking state, occupying ten-twelfths of the respiratory period instead of eight-twelfths. The respiratory pause is absent during sleep, and the depth of respiration considerably diminished."

Precise investigations have shown that "sleep modifies the entire character of the gaseous exchange in the body; there is a decrease in the quantity of carbonic acid eliminated—42 per cent by night as against 58 per cent by day—and an increased absorption of oxygen." During sleep, then, the gaseous exchange in our bodies is diminished. But this is not all. The heart action is modified at the same time as is respiration; the heart works more slowly and less energetically during sleep than when we are awake. "At the same time the peripheral blood vessels dilate, the blood pressure falls, and there is also a certain increase of internal temperature. The minimum temperature is observed between midnight and

three o'clock in the morning, or, according to some observers, between four and seven o'clock. The dilation of the surface vessels appears earlier; they swell in the evening, and thus it is that in the evening we find that our collars and other close-fitting parts of our garments become tight and uncomfortable."

This dilation of the limbs is due to the fact that the walls of the capillaries in the skin become relaxed (or, as it is said, lose their *tone*), with the result that they permit more blood to accumulate there. At the same time there is a general fall of arterial blood pressure, as a result of which the blood flow through the brain begins to diminish in quantity. "After reaching its minimum the brain circulation remains, with temporary variations, practically constant for one or two hours, perhaps longer; then the blood flowing through the brain begins to increase gradually, following the rise in blood pressure produced by the slow constriction of the skin vessels, and becomes more rapid just before spontaneous awakening, when it is approximately the same as when sleep appeared." We see, then, that sleep implies arterial anemia and venous congestion.

Two interesting experiments have been tried on sleeping subjects. One was to see what happened to the volume of the sleeper's arm when a phonograph was played near him. The arm was placed in an instrument known as a water-plethysmograph, a device for measuring very slight changes of volume by means of a capillary tube in which the displaced water rises. It was found that the volume of the arm and hand of the sleeper was reduced when the phonograph was played even before he showed any symptoms of waking up! Another experiment is

the famous one of Professor Mosso. The subject was put to sleep while lying on a board nicely balanced at the center of his body. When the subject, horizontally poised on this balance, fell asleep, the feet began to fall, showing that the blood had left the head, the inclination of the feet appearing to be proportional to the depth of sleep. That the blood leaves the brain during sleep has also been shown where it was possible to examine persons whose brains had been exposed by fracture of the skull. All these investigations showed that the brain grows pale and contracts during slumber, while in the morning, or at the moment of awaking, the brain takes on a rosy hue and even rises in the pit of the fracture. It also appears, from careful tests made upon the state of the reflexes of the body during sleep, that "there is a progressive diminution in the depth of sleep from the brain downward."

Usually the sweat glands of the skin act more energetically during sleep, which, together with the increased amount of oxygen inspired, explains why the atmosphere of our bedroom becomes impure more rapidly than in the rooms in which we carry on the occupations of the day.

Although the internal organs are in a more or less anemic state during sleep, it is possible, especially if we go to bed directly after eating, that all of the digestive processes—those of the stomach, intestines, kidneys, salivary glands, etc.—may be quite active during sleep. The opinion that sleep and digestion are mutually antagonistic is founded on the observations of hibernating animals, whose condition of hibernation cannot be considered a form of normal sleep. In Russia the peasant traditionally goes to bed immediately after his full evening meal.

"What takes place in the central and peripheral nervous system during sleep? Certainly we all know that when they wish to go to sleep animals as well as men always seek a quiet corner, sheltered from every disturbing noise, every bright light, etc., in a word, from all the impressions of the external world. Thus, when going to sleep, we all lower our eyelids over our eyes and seek a comfortable position which will avoid the necessity for any muscular effort. In the arrangement of our beds may be traced the same desire to remove everything which would make too strong an impression on our senses." But this does not mean that the nervous system receives or responds to no impressions during slumber. For even in the deepest sleep observed under experimental conditions, tickling the sole of the foot, the nose, or the ear still causes reflex movement. Sleep, then, is not connected with anything like a paralysis of the brain. In general, also, the reflexes which may be provoked by gently striking some such tendon as the one below the kneecap are much weakened during sleep; besides, the contracting of the pupil of the eye to light is reduced. Such facts as these show that the state of sleep is quite different from the state of exhaustion, for in the latter state the so-called tendon reflexes are all magnified. Rational acts may also be carried on in sleep. The position of one cramped in bed may be changed without waking up, a fly may be brushed off the face, and bedclothes either thrown off or pulled up according as the temperature of the room rises or falls during the night. Sleepwalkers also unconsciously perform many daring feats during their somnambulism. Soldiers often fall asleep during forced marches. In the retreat at the Battle of the Marne the French and British sol-

diers even kept step and held their guns in the regulation position without awaking. "Certain birds always sleep on one leg, and those which sleep on the water in this way have the habit of gently paddling with one foot, thus slowly revolving in a circle," doubtless to keep subconscious watch against danger from any quarter. Questions put to sleepers may be answered without their waking, and even fairly rational arguments may be carried on in this way.

If we may sum up all this evidence in a few words, we can say that sleep, so far as the nervous system is concerned, is a state of merely greatly diminished consciousness, both in so far as the number of simultaneous sensations are concerned, and also in point of the intensity and continuity of responsiveness. We have remarked before the signal importance of the loss of vision; to which we may now add that in sleep the brain, far from coordinating its various activities as is its custom in waking life, deals with only one thing at a time, and that in a more or less desultory manner. The brain during sleep may well be compared with the actions of an insufferably slow speaker who forgets the word or the phrase which he had previously enunciated. Of course this generalization refers more to the deepest stage of undisturbed sleep than to the condition of the somnambulist or the sleep talker, who, it must be remembered, are oftener than not very close to the point of waking up. Again, we must remember that the state of mind with which a person falls asleep determines to a large extent the degree of responsiveness that he will have during the night. The mother who sleeps throughout the thunderstorm may yet rise up the instant her infant stirs in his crib. Mental set, temperament, and autosuggestion

all serve to determine the depth, that is, the quantity and the quality of the sleep. There are persons who can rise any hour of the night they have previously determined upon, or who, if they waken, can tell the time of night within five minutes.

Let us, then, recapitulate our knowledge of the nature of sleep. Normal sleep occurs by virtue of the effect produced by the diminution of the sun's light upon the visual apparatus and the visual field; by local or general bodily fatigue, bringing with it a diminution of the available nervous energy; by voluntary exclusion of sensory stimuli; by the assumption of the horizontal position with its subsequent relaxation of the muscles which keep us erect and keyed up toward the world, and with the accompanying closing of the eyelids; by the diminution of blood in the brain, and the fall of arterial pressure; and by our autosuggestions that we need or want sleep, or by our willingness to become and remain for a while unconscious.

Insomnia furnishes the chief point of contact between sleep and applied psychology. The function of sleep is to provide time for the regeneration of the wasted tissues of the body. When, therefore, sleep is absent, or when it becomes light and fugitive, so that the slightest impression wakens the sleeper, injurious effects are bound to be produced. Insomnia is injurious both to the general health and to the nervous system. Complete and unrelieved cases of insomnia quickly terminate in death.

Excessive intellectual labor is a frequent cause of insomnia, as well as is overstrain due to physical work. Overuse of the brain tends to produce an expansion of the blood vessels of the brain, which, if not followed by ample nutrition of the tissues, may

take the form of a temporary paralysis of the blood vessels. In extreme physical fatigue it is supposed that the heart becomes overactive and sends more blood than the normal amount to the head. Intense joy or anxiety, especially when experienced in the evening, may render sleep impossible. Many students in college, in the attempt to keep awake while studying for their examinations, plunge their hands into cold water, with the result often that the blood is driven to the head for a longer period than they intended, preventing them from falling asleep. Then they begin to worry over their examinations, with the consequence that after lying in bed for several hours they are no nearer sleep than when they retired. Neurasthenics (persons chronically suffering from nervous exhaustion) usually find it difficult to fall asleep, and there are cases on record where the onset of insanity was heralded by from seven to ten sleepless nights.

Most cases of insomnia, however, are not symptomatic of any serious ailment, and readily yield to the proper treatment. It is obvious that the cures for insomnia should aim to produce natural sleep, that is, anemia of the brain with corresponding hyperemia of the skin capillaries. Narcotics and sleeping potions will not do, since they merely annul our responsiveness to the environment. Often warm baths before retiring "greatly contribute to prevent insomnia, if properly carried out. . . . The bath should be taken in a room with a temperature of 65 to 70 degrees F. The patient should stand with his head over the edge of the tub, douching head and face with water at 100 degrees. The cooling of the body by the air and the hot sponging of the head first send blood to the brain, dilating its vessels. Then the

entire body, except the head, is immersed in a bath at 98 degrees, rapidly raised to 105 or 110 degrees; in a few minutes the bath is left, and the body wrapped in blankets which absorb the moisture, and with the least possible exertion the patient gets to bed with a warm bottle to his feet and perhaps a little warm liquid food." In some cases, where hot baths are undesirable, it has been found profitable to place a hot water bottle at the base of the neck for the purpose of setting up local hyperemia, and thus reducing cerebral arterial tension. Spanish women have the custom of rubbing their children's backs up and down the spine between the cervical and lumbar vertebrae in order to lull them to sleep. Enveloping the body in warm wraps produces the same general effect.

One of the best cures for insomnia is "a hundred-dollar bed." The mattress which fits and yields to the curves of the body will itself furnish a stimulus to relaxation. Small, stuffy bedrooms, stuffy not only as respects ventilation but the furniture and bric-a-brac as well, prevent the most refreshing sleep from taking place. Glaring wall papers, pictures that mean anything but sleep, and similar surroundings almost defy the darkest night to reduce their defects to zero. An unnoticed hunger—that is, a too empty stomach—often causes sleeplessness, and should not go unrelieved before retiring. A high pillow will also accelerate the distribution of blood essential to the most beneficial repose, though here great care should be exercised, since often the high pillow produces tensions in the neck muscles which prevent unconsciousness from supervening.

Finally we may mention the peculiarly psychological devices for encouraging sleep, such as

monotonous sounds, not too loud, and not too rapidly succeeding one another, which so many persons have found helpful in insomnia. But even more than this, the person who lies down to sleep in "the hundred-dollar bed" we have just mentioned will find it extremely advantageous to see to it that after elaborate stretching and yawning he thoroughly relaxes every muscle in his body. He should begin with his head which should be allowed to sink well into the pillow. He should then lift and retract his eyeballs, slightly drop the lower jaw, unstiffen all the facial muscles, including the tongue, and thoroughly unbend every rigidity all the way down the spine, the arms, and the legs, until he lies as helpless and inert as possible. For since mental activity is always connected with muscular responsiveness, rousing thoughts can be checked by putting the response mechanism out of action. Especially is such a deliberate relaxation essential where the person goes to bed only to lie awake "mulling" over some unfinished problem of the day, and "stewing in his own juice" about matters that are not at all urgent at that particular time. There are people, one of whom the reader may recognize in himself, who actually hold their heads up and off from the pillow without knowing in the least to what an extent their rigid posture is preventing the much-wished-for sleep. And let us add as a last practical psychological hint on this matter, that if insomnia is caused by a man's inability to balance his mental books at the close of the day, he had better rise and finish what he had left undone, especially if it be obligations he has neglected, or at least plan how to settle those important matters which hinder him from entering into a sound and dreamless slumber.

CHAPTER XXVIII

DREAMS

IF myth and legend are to be believed, dreams played an important part not only in the religion of primitive man, but also in his political and economic life as well. In ancient times dreaming was regarded as a dependable method whereby secrets might be revealed, future events foretold, and contemplated actions or journeys assured of their success or wisely prevented. The seer was a dreamer, as well as an enthusiastic and poetical interpreter of his nightly visions.

Scientific civilization has brought with it a decidedly changed attitude toward dreams and their significance. To-day, even though the fortune teller's "Dream Book" is for sale at every bookstore in the country, it is sold chiefly to those who are seeking for diversion and amusement. This is not because dreams are of no importance to us, nor because we have all been convinced of the truth of the German proverb, "Dreams come from the stomach." Nor, on the other hand, is our lack of belief in the revelations of the "Dream Book" based on the fact that "science has laid her doomful hand" upon the occult. We are not at all skeptical about the matter—we disregard the "Dream Book" simply because it treats all dreams whatsoever as prophetic, whereas we feel very sure that most of our dreams refer not to the future, but to the past. Modern psychology has veri-

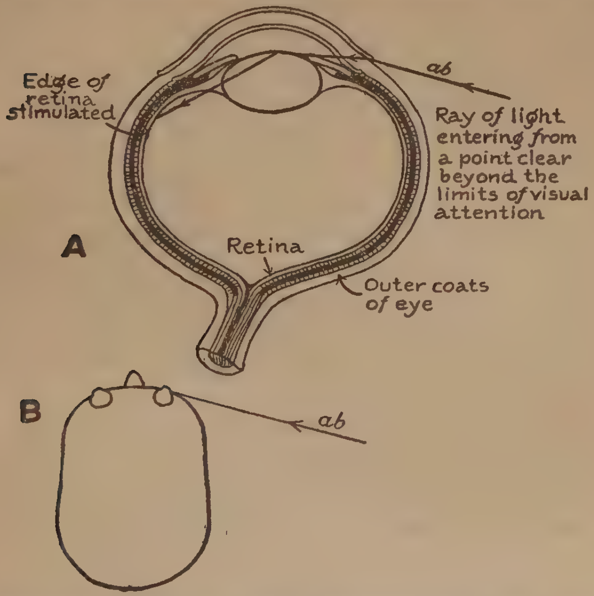
fied this popular, age-long intuition of ours, as well as it has shown in a great number of cases just what forgotten but significant part of the past our dreams refer to, and why their material is presented in such a disorderly and quaint panorama.

A dream is a drama whose plot revolves about either a wish or a fear. The dreams of happy and care-free children are usually pleasant and luxurious continuations of their waking imaginations, such as the sugar-plum mountains, the elfin folk in the wood, and the pyramids of sweetmeats they talk about to one another or read of in the fairy tales. Such free-wishing dreams are not confined to children. Many an older person takes a similar "mental outing" during sleep, especially he who is deeply in love or who is expecting to come into a large and comfortable fortune. Dreams whose chief element is fear are due either to a disordered stomach, such as is produced by a late, rarebit supper, to an impending disaster or loss which the dreamer had been warned of during the day, or else they are due to a very old and long-forgotten painful experience which suddenly gets redramatized in sleep. To classify all dreams as either wish-dreams or fear-dreams does not mean that the same dream may not be a mixture of wishes and fears, nor that both the wishes and the fears need to be revealed in their true nature to the dreamer. Indeed, all gradations of clearness, orderliness, and emotion may be shown in the dream state, as every dreamer can testify.

Though the plot of the dream always revolves about something desired or something of which we are apprehensive (and of which we are by day strangely unaware as part of our mental nature), the dream may have many a contributing cause

whose origin is quite direct and immediate. For example, the sleeper's cramped bodily position may arouse a dream of stumbling (through his ineffectual attempt to change this position without waking up), or it may stimulate a dream of being seized by ruffians and badly manhandled. The subconscious fear behind both of these dreams is very easy to point out. We have all stumbled in our lifetime, and the fear of the consequences of stumbling badly is a part of our everyday education. The sleeper's posture in bed had become a sort of semistumbling posture, and thus it was interpreted by his subconscious mind. But every such posture has many points in common with severe bodily discomfort. One ankle-bone may have been pressing into the other foot, giving rise to what in waking life would be called a sensation of pain and crowding. This the sleeper's subconscious mind dramatized as a rapacious, manhandling attack. Perhaps the fear of such an attack had been fostered in the sleeper's mind the day before by some newspaper story of a holdup. If the dreamer was at all a timid person, such a fear would, of course, be lodged very deeply in his mind. Other common dreams have a like origin. The high temperature during sleep which is produced by too many bedclothes is a well-known cause of dreams of tropical countries, of ovens, or of dense, panicky crowds, depending upon which wish or fear is subconsciously aroused by the pressures upon the sleeper's body. Likewise the bite of a fly during sleep may reawaken the long-forgotten memory of the sting of a wasp, of an experience with an air gun, or of an escape from being struck in the face by a baseball. Precise experiments with sleeping persons have verified all of these causes and effects. A cardboard edge

drawn slowly across a sleeping man's throat can arouse a dream of the French Revolution with its fascinating but atrocious guillotine. In all such cases the sensory stimulus is not felt as such—it is always used as a vehicle for the revelation of some old,



THE DIAGRAMS SHOW HOW MUCH OF THE MATERIAL OF DREAMS MAY BE DUE TO RETINAL IMPRESSIONS TO WHICH WE PAY NO HEED. THE LINE AB IN EACH DRAWING IS THE SAME

slumbering, subconscious wish or fear which still secretly dominates the dreamer's mind.

To produce a dream, however, it is not at all necessary to give the sleeper a vivid or a violent sensory shock. Much dream material is made out of fleeting or neglected trains of thought left over from the previous day. Sights and sounds of which we were only vaguely conscious at the time of their occurrence

may enter the dreamer's mind with an unusual vividness. A visitor arriving very late at his friend's house had a dream that night of being pursued by many large snakes. In the morning he remembered his dream, but could in nowise account for it. However, upon going down the stairs, he saw a large, wooden clock, carved with all manner of snakes and dragons, which in the dimly lit hallway the night before he had seen only out of the corner of his eye. A great many of our dreams simply render very vivid just such unnoticed events out of our waking experience. The field of vision is, of course, very much larger than the field of attention, and so millions of faint impressions can be stored up in our minds without involving any conscious effort whatsoever. It is out of just such faint impressions that our wishes and fears create many of their strangest dream dramas.

To be sure, since not every dream gets reported and analyzed, it is impossible to say that every dream whatsoever can be fully explained to the dreamer's satisfaction. Some dreams also are forgotten upon awakening, while others are much distorted in the telling of them. Nevertheless, in all the scientific work upon dream analysis that has been done, something significant to the dreamer is revealed in his every truly reported dream. Indeed, the motto of one school of psychologists is "Tell me what you dream, and I'll tell you what you are." Some of us, of course, would deny that there was any important connection between our dreams and our deepest motives. But if we remember that even by day when we are most alert, many of our traits of character may be much clearer to others than they are to ourselves, it will not seem strange that at night, when the upper

consciousness which was formerly in watchful and wary control is sunk in slumber, many a trait of character unsuspected by ourselves may stand out in bold relief in our dreams. Even a saint may dream more or less fondly of pleasures he has long acquired the power to spurn.

The fact that "dreams often have the character of dissolving views" simply means that numerous and varied wishes are crowded into them. A train of thought, interrupted during the previous day and not taken up again, may be tucked in between two very remote events which have no obvious connection with one another. All this may be quickly terminated and give way to an unsolved problem or to some rejected or suppressed idea, the whole dream ending suddenly in a military drama which the sleeper's subconscious mind constructs around the ringing of the alarm clock which finally wakes him.

We have already characterized the dream as a dramatic interpretation of sense impressions which various stimuli make upon the sleeper. But the dramatization in dreams extends much further than this. Scarcely anything which the dream means is clearly revealed in the imagery which the dreamer experiences. Events of the night or of previous years may be so condensed as to become unrecognized by him. Two houses in which he has lived may combine, having the walls and windows of one, and the door knobs and hallways of the other. Animals more grotesque than the centaur and dragon of fable may be produced by this process of coalescence, and in the same manner a personage who appears utterly unfamiliar in the dream may be nothing more than the fusion of the dominant traits of two or more people each one of which the dreamer knows very

well. Again, dreams often show a certain odd displacement of logical emphasis. The most obvious and memorable feature of the dream may not be the bearer of its most significant meaning. This is particularly true of nonsensical dreams which often wake us up laughing.

The foregoing mechanisms of the dream drama may all be illustrated by the following: An author dreamed one night of putting down linoleum over a large floor. The pattern on the linoleum was very faint, too faint, indeed, to be deciphered, and seemed also to be discontinuous. When he finished covering the floor, he looked up, and to his astonishment saw that not only the walls, but the ceiling as well were covered with the same material. As the dream faded, the linoleum appeared to be of a greenish hue, and the tacks with which it had been fastened down all jumped out. The interpretation is this: The linoleum of the dream was a dramatization of some carbon paper which the author had forgotten to pack flat in his trunk before going on a trip, and which he had hastily rolled up and tucked in his suit case. The carbon paper was to him a symbol of his profession, and to unroll it would mean "getting back to work" or "making a living." Now "making a living" was symbolized in his dream as "covering the floor, walls, and ceiling," that is, "providing shelter and comfort for himself." The faint pattern on the linoleum meant either a carbon copy of what he was writing or else that the carbon paper had been used so often that no sentences could be deciphered upon it. The green color of the linoleum was an example of the working of an extremely subtle subconscious process. Green is the complimentary color, i. e., the *psychological opposite* of red. The "red" of the

dream is subconscious misspelling, or punning on the word "read," i. e., placed in the hands of the publisher. As a matter of fact, the author had an unfinished manuscript which he was in haste to complete and anxious to sell. The tacks jumping out of the linoleum symbolized his anxiety about the manuscript, i. e., that it might not sell and that he would consequently be deprived of the money (comfort, shelter) he was expecting it to bring. Such a dream drama shows how even the most serious wish or fear may be pictured by absurd events.

All this, however, fails to explain why dreams take the form of curious, puzzling, nonsensical, or bewildering dramas. Why are events misplaced and distorted, why do familiar things appear unusual, and why are we deceived as to the significance of our own dreaming? The answer is not hard to give. The dramatic, distorted, and even idiotic character of our dreams is not by any means an accident; it is simply a device which one part of our minds employs in order to think without unduly disturbing the other part. The dream is a *psychic camouflage.* Our deepest wishes, our unfinished trains of thinking, our unbalanced mental accounts do not cease to affect us when sleep overtakes us; for while they may be consciously forgotten at the moment of falling asleep, as soon as we are deep in slumber, our whole subconscious mind begins to put its many energies into motion. But these energies, these wishes and fears, these forgotten and neglected ideas, these social and intellectual obligations could not possibly be given free play without spoiling the effects of sleep or waking the sleeper. Hence the *camouflage* of dreams. Their deceptions are one and all intentional, for the subconscious uses all these dra-

matic devices in order to release the long pent-up energies of its fear and desires without rousing the sleeper and spoiling his rest. Sometimes, of course, the camouflage fails, and then we have the nightmare or some other unlovely awakening, but usually the subconscious is subtle enough to accomplish all its purposes successfully. For, as many have had occasion to observe, even the alarm clock may be dramatized into the sound of the fire bell or the whir and clank of a motor car.

Not only in dreams, however, are subconscious devices employed to evade our upper consciousness. The woman who puts some cherished trinket away too safely to find again easily, the man who mislays the bill he solemnly promised to pay promptly, and the boy who on his way back from the store loses the package which fretted him to bring home all illustrate how in the same person there may be at times what amounts to two distinct minds, each with a different set of thoughts and purposes, and each somewhat out of harmony with the other. And just as we often have two minds or two separate streams of thought in waking life, so may we have them in sleep. The difference, however, between our waking and our sleeping life is this, that in sleep the two streams of thought never hinder each other as they do in waking life. In sleep the protection of the sleeper against awakening is the whole mind's paramount concern. And in thus protecting us during sleep from the shock which a full realization of our deepest wishes and fears would bring, the subconscious mind performs a curious and valuable service in our mental economy.

While we have no certain knowledge of the nervous mechanism of dreams, it is nevertheless likely

that a dream involves very elaborate brain activity. Of course, not as much of the nervous system can be concerned during sleep as during waking life, since many of our day-time activities have then ceased; but if dreams are *camouflaged* wishes and fears, it is reasonable to suppose that they are produced by just as complicated brain action as is involved in any conscious behavior. And while less of the brain is involved in dreams, that part which is active is more riotous and uncontrolled than during waking life. And if it be asked, "What really does the controlling in dreams?" the answer is that the mental attitude with which we fall asleep persists more or less completely throughout the night, and acts as a check on all brain excitements which might arouse and disturb us. The very fact that we lie supine and flexible, and intend to remain so till we awake, exerts its influence upon our nocturnal mind. Since such postures of the body as the erect spine and the alert eye influence us by day, it is not surprising that the relaxed spine and the reposeful face should wield an equally important controlling influence by night.

The mechanism and the meaning of dreams are two of the most fascinating problems in all psychology. And, from what we have already said, many of our dreams have a very deep significance, not so much as prophecies of what is to come, but rather as hints of what sort of wishes and fears our subconscious mind entertains. "That Roman emperor did well," writes one psychologist, "who ordered the head of one of his courtiers to be struck off because he had dreamed that he had killed his sovereign." For the emperor well knew that the lip praise of his courtiers did not always represent their complete opinion of him. However, the emperor could have been completely

mistaken, for the courtier might have feared a plot to overthrow the emperor, and his dream might have symbolized his exasperation at having tied up with so unsuccessful a monarch.

From this it can be seen that no satisfactory book of dream interpretations can ever be written. If the dream pictures mean a wish, one interpretation will be given to them; while, if they mean a fear, another and contradictory interpretation will be supplied, and neither can be absolutely proved to be the correct revelation. Yet, often the case is so clear, and our subsequent behavior so illuminating, that we are able to interpret our dreams with great fidelity. But since each man has his own private and peculiar dream symbolism, he will have to work out his own interpretations, especially in the doubtful cases.

It is not wise to lay too much importance upon dreams. Many of them, far from being true hints of our future behavior, merely indicate disorders of digestion, or of vision, or some other important bodily function. Besides, many people do not know how to relax properly before falling asleep, and their dreams simply represent the lack of happy, physical repose. The "real self" is not the self of dreams, any more than the real self is the angry self, or the generous self, or the stingy self. We are all of us many selves, each one of which is just as real as the others. Hence we may say that dreams represent the stresses and strains of the mental and the physical life more than they represent any deep, central personality, or any evil genius which guides our destiny. Besides, the dreamless sleep being the more refreshing, too great attention to dreams may serve, by encouraging them, to hinder the recreative process which it is the business of sleep to provide.

CHAPTER XXIX

SUGGESTION

"NOW watch me closely," says the magician on the stage, and then adds roguishly, "for I shall deceive you." At the same time he shows you a bright red ball which he tosses once or twice in the air. Then, catching it between his second and third fingers, he stretches out his arm, and with a quick motion of the hand which holds the ball produces apparently from nowhere another ball the exact duplicate of the one he first showed you. The magician looks surprised and so do you, while your astonishment increases to the point of perplexity when, by a simple turn of his hand, he causes one of the balls suddenly to disappear. "Impossible!" you inwardly exclaim, "and yet," you silently argue, "since he neither threw it away nor dropped it, it must be somewhere—but *where?*" You believed a moment ago that there were two balls, and now you believe there is only one. A psychologist would say that you were extremely suggestible to both these illusions, since the second ball is nothing but a hemispherical shell which fits, whenever the magician so chooses, snugly over the other.

Suggestion is one of the most powerful, habitual, and subtle factors in all our mental existence. The tendency to yield without serious question to the ideas, opinions, and persuasions of another is, indeed, universal. It is due to our suggestibility that

we assent to the orator's arguments, become pliable under the cross-questioning of the lawyer, and accept social invitations one day from which we try to excuse ourselves the next. It is suggestion that operates to the advantage of the advertiser, whose announcement of bargains draws a crowd to his store; it is suggestion that plays the high card in the spiritualist's séance and the palmist's parlor; and it is the same phenomenon which lies at the root of the maxim "A word to the wise is sufficient." Suggestion enters into much of the confidence and trust men display toward each other, and it is likewise the basis of suspicion. Shakespeare makes a whole tragedy follow from the extreme pliability of one of his characters, for Desdemona's death is traceable to Othello's readiness to accept and elaborate the diabolical suggestions of Iago.

Suggestion is so very much like imitation that it is often difficult to make any hard and fast distinction between them. For whether we accept the opinions of another or copy his actions, we are allowing ourselves to be led by him into paths he points out for us. In either circumstance it is a case of "you lead and I'll follow." Psychologically, the main distinction is this: that when we imitate another's action we have a complete pattern to go by, whereas in pure suggestion we take the main hints from the other person, but fill in the details as it suits us best. That is to say, our suggestibility depends upon the extent to which we are given to autosuggestion, for in almost every case in which we accept the ideas of another, we add ideas of our own. This is especially true in gossip and rumor, where the merest hint of suspicion is often magnified into volumes of fantastic untruth.

Autosuggestion, then, is the basis of all suggestibility. What others say and do excites imitative tendencies in us only in so far as we have subconscious leanings in that direction. The suggestions of others derive all their potency from our own hidden trends of thought. However, autosuggestions may be aroused in us, not only by the looks and voices of other people, but even by books and by physical events. For example, a timid child sits up till late at night reading a fascinating ghost story. As he finishes and closes the book, the wind rattles an open window near by. The child, startled, drops the book on the floor, looks pale, "freezes" with terror, and remains rigid and motionless. Ordinarily, that is, in broad daylight, the rattling window would be unnoticed, but not so after reading such a book as "The Hound of the Baskervilles." The child's mind has been filled with the mysterious events of the story, and these now become the dominant elements of his nature. The rattle of the window is not really perceived as the work of the wind; something uncanny and supernatural seems to be producing the sound. Thus the rattle becomes *over*perceived, or *pre*perceived, in terms of the child's mental background. This is a vivid case of autosuggestion.

The reader will instantly supply similar examples of autosuggestion from his own daily and nightly experience. And a little use of his powers of observation will convince him not only that autosuggestion is essential to suggestion, but also that autosuggestion is never wholly absent from our minds. Our frequent misinterpretation of street-car signs, of the headlines in the newspapers, and of telegrams; our mistaking another's umbrella for our own, and many other successful as well as lamentable blunders are

simply the result of powerful autosuggestive tendencies in us busily at work upon all our conscious intentions to modify them. Slips of the tongue and of the pen, the mislaying of bills, and the putting away of objects so safely that we have much difficulty to find them again are to be explained on the same principle.

Again, we notice the effects of autosuggestion in the person who cannot sleep except in his own bed, or only on that particular side of the bed where it has been his wont to lie. Cases are on record of people who were so accustomed to sleep on their right side that when they broke their right arm and had to lie in an unsual position, they were totally unable to fall asleep. The tenacity of habits is greatly strengthened by autosuggestion, and the breaking of an injurious habit is often retarded because of the subconscious tendency to suggest our unwillingness to lose it. Our feelings of well-being or of ill-being are often largely due to our confidence or suspicion. In such a fact lies much of the power of Christian Science, and all the success of the fake medical advertiser. Of course, as may have been suspected, without guidance and correction, autosuggestion may become the veriest nuisance.

We are, however, obliged to carry the notion of suggestion even further. For there is scarcely anything that we see, hear, smell, taste, or handle that is not somehow or other subject to our autosuggestions. Especially is this noticed in our ordinary conversations, where many words carelessly enunciated are nevertheless heard as if they had been faultlessly pronounced. If you listen the next time you are talking to an intimate friend, especially over the telephone, you will notice how many gaps of

sound you fill in with your knowledge of language and grammar. Indeed, it may be truly said that we never perceive anything at all, especially something familiar, without there being an element of personal bias, illusion, or autosuggestion in it. We treasure many things very highly which have no intrinsic value whatever, but which, on account of tender associations of long standing, it would trouble us as much to lose as our money or our real estate. All such things retain their worth by virtue of the unconscious autosuggestions we employ in their behalf. Passers-by may stop to admire a house whose beauty the owner can no longer see on account of the mortgage which is about to be foreclosed upon it.

Although it is possible to expand the meaning of suggestion to the very limits of mind, ordinarily when we use the word we mean simply that the ideas of another are presented to us for our acceptance, as for example when we sit in the theater and yield to the illusions of the hour. Under such circumstances we are able to study the laws of suggestion by varying the factors which produce it. It has been shown that nighttime is generally better than day for producing suggestibility, that fatigue or sleepiness increases it, and that on the whole children are more suggestible than their parents, or at least, in more directions. It is also usually the case that when one suggestion has been accepted, another will be more readily assimilated, that precise appeals to our oldest associations help to increase our tendency to assent, and that questions put to us whose answer helps us to conceal any painful thought will likewise be provocative of increased suggestibility. Nevertheless, such laws hold only in the main. For even though it be true that most people are more sug-

gestible by night than by day, yet when we come to examine individual cases, we find stranger differences of suggestibility than we thought possible. One of these differences is that, depending on the time, the place, and the manner in which the idea is presented for acceptance, some people are positively and others negatively suggestible. The habitual optimist and the confirmed pessimist are beautiful examples of exceptions to the general law that we have stated above, since they both negate the effect of the stimulus by their powerful autosuggestions. Again, two salesmen from the same insurance company may both use the same method on the same prospect, and yet, owing to the mood of the prospect, one of them may succeed just where the other failed. Indeed, when we come to the fine point of the matter, we see that the same man may be positively suggestible in one respect, and negatively suggestible in another. Our suggestibilities may also change without our knowing it, or they may change more rapidly than we are aware. The girl of the story who sat in the telegraph office and penned alternately acceptances and rejections to her lover's proposal is the classical example of this alternation of tendencies. On the whole, however, we all tend to exhibit some fixed type, and it is well that this is so, for otherwise we might not be so dependable in our friendships or our business.

A British psychologist, Bernard Muscio, has recently thrown much light on the influence of the form of the question which is put to a witness in the court room to draw out various kinds of answers, and thus test his suggestibility. Ten different kinds of simple questions were employed by Muscio in his experiment, and the results were carefully recorded.

Three points were noted, (1) the suggestibility, (2) the caution, and (3) the reliability of the witness. Strange to say, the results hinged upon the presence or absence of very simple words, such as "a" or "an," "the," "not," "or," "you," and the like. Suppose the witness has seen an automobile accident and is being asked the particulars of the event. The lawyer questions him: "Did you see *a* Ford car coming up behind?" (without, of course, accenting the article "a"). The answer of the witness will be different from what it would have been if the lawyer had said: "Did you see *the* Ford car coming up behind?" Just that little change from "a" to "the" will induce a different kind of autosuggestion in the mind of the witness. Muscio found that in the main the latter type of question (the one using "the") decreased the suggestibility, caution, and reliability of the witness in comparison to what it was with the use of the article "a." Of course the witness was more or less on his guard, otherwise the definite article "the" might have had far different effects on him, since the use of this word assumes that there really was such a car on the road. Again, the witness was asked, "Didn't the wrecked car skid before it stopped?" and it was found that suggestibility was greatly increased, although caution and reliability were decreased. This is not to be wondered at, since it is a common trait of human nature to be self-assertive and to attempt to settle open questions. A third kind of question showed the difference between asking a personal opinion of the witness and asking him to report on the bare facts of the case. It was found that to ask for a personal opinion or estimate greatly increased the suggestibility, but at the same time increased both the caution and the re-

liability of the witness. As a final example, a fourth pair of questions was put: (1) "Was the man in the car Johnson *or* Brown?" (2) "Was the man in the car Johnson?" in which case it was found that the latter form of the question had a higher suggestibility value than the former. It is a very interesting and profitable experiment to try some of these question forms on one's acquaintance. Not only will it show how pliable is human nature, and how subtle is language, but it will also reveal how the subconscious may be tapped without our being in the slightest degree aware of what is going on.

These examples will suffice to show how large a part suggestion plays in all our minds. And if our suggestibility so constantly modifies our perceptions of what we call truth and fact, that is, the things we see with our own eyes, what shall we conclude about the exactness of our knowledge of many events in history of which we have only the vaguest report? Does not much history at once become the thin, gauzy fabric of illusion, especially those events which have to be pieced together from fragments of hearsay, from inscriptions on monuments, and from excavations in long uninhabited lands? Does not likewise a great part of geology, as well as the speculations about the habitability of Mars become as romantic as the tales of the Arabian Nights? And yet one can well believe that were not man thus prone to autosuggestion there would be less confidence in the future as well as less ambition and determination to achieve those purposes which he foresees as valuable and noble. For while our suggestibility makes us constantly err, it also makes us tide over many a difficulty and keep up our courage until better times and conditions come to our aid.

CHAPTER XXX

HYPNOTISM

PERHAPS no other mental phenomenon arouses so much astonishment or makes so many people assert the working of mysterious agents as the phenomenon of hypnotism. In former times satanic powers were supposed to be the direct causes of it, and even in our own day we hear of a "malicious animal magnetism," which one person is said to be able to exercise at will over another.

Strange and remarkable as hypnotism is, however, there is no need to fear it or to attribute it to anything uncanny or supernatural; for hypnotism is simply a special case of suggestion, and it exhibits natural laws in the same way as do the tides or the comets.

Much of the mystery that surrounds hypnotism is due to the fact that the professional hypnotizer intentionally makes something mysterious out of it for his own personal gain. The rest of the mystery is largely supplied by the autosuggestions of the onlooker, who more often than not is quite willing to indulge himself in some mystical ideas for the sake of getting his money's worth out of the performance. Perhaps, also, some little of the curious reputation which hypnotism has gotten is due to the exaggerated reports which the onlookers at an exhibition of hypnosis supply and which become inflated by passing from mouth to mouth. Let us here carefully

distinguish between a true and a false report of the hypnotist's power.

First let us have the true report. At a vaudeville performance a professional hypnotist appears on the stage and asks whether any one in the audience wishes to be hypnotized. At once several people rise in their places, come upon the stage, and, before the audience is fully aware of what is taking place, are put into an apparent sleep by the hypnotizer and piled up on the stage like cordwood. One of the volunteers may be commanded to laugh uninterruptedly, which he does; another may be rendered rigid and placed neck and heels on the backs of two chairs, where he lies as stiff as a poker until he is commanded to awake and is helped down. He is asked whether he has felt uncomfortable while lying there, to which he truthfully answers "no." The one who laughed so long is asked why he did so, to which he replies that he had no notion of what he was doing. The pile of human cordwood unstiffens, and the human "logs" resume their normal attitudes without the slightest intimation of the odd sight they recently made. Now all this is true, and it happens somewhere every other day of the year. The hypnotizer actually took away the ordinary feelings and memories of these people. But the hypnotizer is not therefore a satanic agent. He is simply a man well practiced in a particular art—an art that almost anyone can learn within a few months. His victims are human, too, but, mark this well! they are not people taken at random from the audience, nor are they really volunteers; they are part of the hypnotist's company of entertainers whom he carries from place to place, and who are now so dominated by him that they are nothing but pliable puppets. The call

for volunteers in the theater is their precise cue to become hypnotized—by the time they are on the stage they are sound asleep in the hypnotic trance.

Now for the false report. On the motion picture screen appears a picture of "Professor" D—— sitting at his window with a crafty look in his eye and surveying the crowd in the street below him. His finger points to a passer-by, who halts, turns, and does the hypnotist's bidding. One man from the crowd, thus spellbound, picks a pocket; another, equally bewildered, goes through all manner of ridiculous contortions; while a third is obliged to climb the stairs and serve the hypnotist as he directs. None of this is true. No man can exercise such power over a fellow being, and no one can be hypnotized against his consent.

The road to hypnosis is through suggestion. Hypnotism is nothing but a case of two people freely cooperating and combining to carry out the commands which one of them, the hypnotist, gives to the other, the subject. But special conditions must be fulfilled before this can take place. For while many a man does as another tells him in everyday life—in business, in war, and at social functions—it requires a peculiarly intense and thoroughgoing cooperation before one man can be hypnotized by another. The subject must first wish to be hypnotized, and must believe that the hypnotizer can do it. The subject sits in a comfortable easy chair and relaxes. The hypnotizer then suggests to him certain of the phenomena of sleep, that is, that his eyes are growing heavy, that his eyelids will close, and so on. All this the subject must unreservedly believe. Any part of the subject's body that the hypnotizer wishes to control, or any movement that the subject is to make,

is mentioned or described. The hypnotizer gets this control by the simple affirmation that the phenomena are present or are about to appear. The customary method is to make the affirmation and touch the part of the body which is to be affected, while the hypnotizer explains in a loud, convincing voice the process that is involved. Of course it may be that this particular subject is not exactly suited to the particular method employed, or that another hypnotizer could produce the effects more readily, but whoever the persons thus cooperating in the situation are, the method is no more complicated than we have described and the process no more mysterious than that involved in any other mental phenomenon.

By means of suggestion the hypnotizer is able to produce, influence, and prevent a very great number of bodily and mental functions. The principal exceptions are the spinal reflexes, and certain functions of the cerebellum and medulla. But upon all such functions as digestion, sweating, skin sensations, arm and leg movements, yawning and sneezing, moods, impulses, and general feelings the hypnotizer can achieve in most cases an unusual degree of control.

The movements of the arms are singularly easy to control in hypnosis. The subject is told that his arm is stiff and that he cannot move it. At the same time the hypnotizer raises the arm. The subject holds it in the air motionless and rigid. The subject is told that his arm is paralyzed and that it will fall like lead. The arm falls at once and cannot be moved. In the same way, every voluntary movement and every possible muscular position of the body may be produced or prevented. Speech, stammering, drunken staggers, convulsions, contortions, and the like may be manipulated at the will of the hypnotizer.

The special senses of sight, hearing, smell, taste, touch, and the like may be influenced in the same manner and to the same degree. The subject is told he has a disturbing mosquito bite on his right cheek. At once he grimaces and starts to scratch it. He is told that one leg is warm and the other is cold to which he agrees at once, and starts to wrap the cold leg in his coat. It is suggested to him that a savage bulldog is rushing at him and barking, upon which he makes the appropriate movements of defense or flight. He is handed a lead pencil which he is told is a bunch of violets, whereupon he sniffs with apparent enjoyment the object held out to him. The same glass of water may be offered to him as quinine, salt water, moxie, or hot chocolate, and he will deal with it in each case with the same pleasure or dislike that he would if it were really so. In most cases not even the glass of water is required. Pain in any part of the body can be suggested to him and he will feel it, especially if the location of the pain and the contortions attending it are precisely described. A headache or toothache which the subject may have had before the hypnotic trance may likewise be removed in a few seconds or at most in a few minutes.

To some people the most astonishing thing about the hypnotized person is his remarkable increase in the power of discrimination. For example, there are cases on record of a hypnotized subject being shown a hundred sheets of white paper, all exactly alike, one of which is chosen at random and shown to him with the remark, "This is a picture of General Pershing." He is asked to look at the picture very intently so that he will recognize it when he sees it again. The paper is then mixed in with the other sheets and lost to view, after which the whole packet

of paper is shown to him a sheet at a time. To the astonishment of all observers, as soon as the "picture" sheet is displayed to him, he at once recognizes it. Of course the sheet of paper must be capable of some sort of identification by the hypnotizer, as, for example, by means of some very unobtrusive mark on the other side. This is indeed truly remarkable. What it means is that during the hypnosis the subject's eyes have been rendered extremely sensitive and able by the power of suggestion to discriminate ordinarily unnoticed differences. No two sheets of the packet were *exactly* alike, any more than the proverbial two peas are in all respects the same. The subject had become as it were *all eye*, and he looked at that paper with the same keenness as an expert in a paper mill would use. Coupled with this his imagination of General Pershing was united with certain minute features of the surface of the paper, and as a result the combination was the "picture" to him.

Defects of various sorts can be readily suggested, such as numbness or lack of sensitivity in a limb, inability to smell, partial blindness, color blindness, double vision, deafness, lack of taste, and the like. Dr. Forel writes: "I have had teeth drawn from my patient's mouth during hypnosis, abscesses opened, corns removed, and have made deep incisions without the least pain having been produced. It is sufficient to assure him that the region is dead and insensible. Surgical operations are possible with hypnosis, although this is rarer, and in these cases it can replace chloroform anæsthesia with advantage, and without the dangers of the latter. But the fear of the operation generally disturbs the suggestibility, especially when the patient witnesses elaborate

preparations. The greatest practical difficulty is met with here."

Reflex actions involving breathing, the circulation, and similar organic functions are likewise open to hypnotic suggestion. The subject will yawn if told to do so, and will carry out the command to sneeze three times in quick succession. Hiccoughing, sweating, blushing, and becoming pale may be controlled, and nose-bleeding can be started or stopped. The therapeutic value of hypnosis can be seen in its control over even obstinate cases of diarrhœa and constipation. Perhaps the strangest effect of all which the hypnotizer produces is the creation of welts or wheals (sometimes called "stigmata") on the flesh by simply touching the skin with a finger or a pencil. It has even been demonstrated that simply by writing the subject's name on his skin with a pencil welts following its pattern will arise. This is called dermographism.

Feelings, impulses, and disturbances of mood are easy to suggest during the hypnotic trance. Appetite, thirst, and the sexual impulse need only to be affirmed to be felt. Jealousy, anger, hatred, love, fear, and happiness may be produced for at least a short time, and laughing and crying can often be prolonged over a considerable period. Memory, imagination, and volition are also influenced very easily. The hypnotizer says: "You will forget all that I have told you while you are asleep and will only remember that you have had a kitten in your lap and have stroked it." Upon awakening the hypnotized person remembers nothing save the kitten episode. A woman who spoke French very well was told while under the influence of hypnosis that she would be unable to speak French again until the

hypnotizer talked to her in that language. And the result was as predicted. It is much easier to deal with a definite feeling or emotion than with any general mood or temperament. The craving for alcohol, for tobacco, or for any other stimulant or drug is much more easy to govern than constitutional characteristics. A temporary aberration of the will can be much more readily brought about than its permanent alteration.

Curious and interesting as are the actions of a person during the hypnotic trance or dream, the actions which may be performed as the result of suggestion upon awakening are even more so. For example, the hypnotizer may say: "When you awake you will see me dressed entirely in scarlet, and with two horns on my head. Apart from this, my wife, who is sitting next to me, will have disappeared, and the door of the room, too, will be gone, and will be replaced completely by wall paper and paneling, so that you will be compelled to leave the room by the other door." All of these suggestions are carried out. When the subject awakes, he sees the hypnotizer dressed in red with two horns on his head. He even says he feels the horns if asked to touch them. He cannot see the hypnotizer's wife who has remained all the time in her chair. If told to feel the chair he feels all around the woman and believes that he is touching either the chair or an invisible resistance, according to the way in which he has employed his autosuggestions. He sees only one door to the room. In place of the other he sees wall paper and panels, and even asserts that these are what he is touching though his hand strikes the knob of the door. Of course these post-hypnotic suggestions last as a general rule only a short while, though

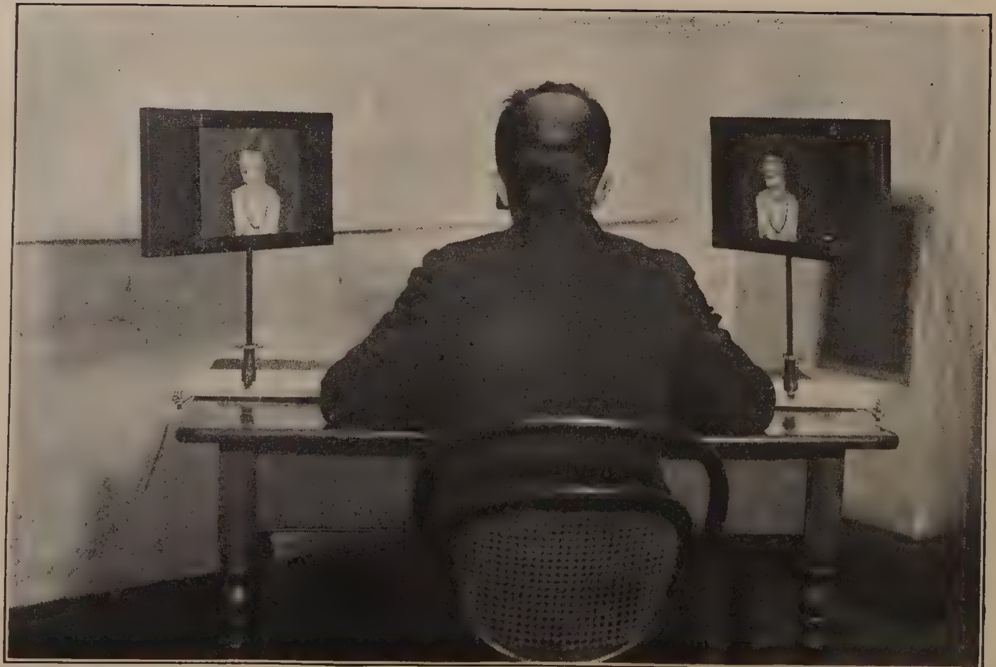
in rare cases they may not disappear for a week. It is even possible to get the subject to perform these suggested actions at a definite time of day. Precisely on the stroke of the hour, the subject may either write a letter, go to bed, or run hatless around the block in obedience to the hypnotizer's command.

These post-hypnotic phenomena as they are called often play a great part in the curing of diseases or in the uprooting of useless habits. Depending upon the suggestibility of the subject and upon the skill of the hypnotizer, and especially upon the energetic repetition of the command the subject will carry out the post-hypnotic suggestions to the letter. However, if he is asked why he does this his answer may vary according to his character, temperament, and education. Suppose a hypnotized subject is told that when he is awakened he will want to place the lamp on the floor. He is then told to count up to six, after which he will awaken. He counts and when the number six is reached he opens his eyes, looks sleepily in front of him and regards the lamp intently. He reaches for it, and, sometimes in quite a state of bewilderment, places it on the floor as he had been told to do. "Why did you do that?" he is asked, and his answer at once reveals that there is a struggle going on in his mind against the powerful suggestion of the hypnotizer. Six kinds of explanations from such a subject have been recorded. One person says: "I remember you told me to do that while I was asleep." A second says: "I dreamed something about doïng that." A third says: "I simply had to do it; I don't know why." A fourth says: "I got the idea somewhere that I ought to." A fifth may say: "I didn't like the lamp and it was in my way." And finally the sixth may put the lamp

down on the floor and immediately forget that he has done so, as if he had just that moment come out of his sleep. This last type of action is very closely akin to somnambulism.

It is commonly thought that the hypnotized person is absolutely under the influence of the suggestions of the hypnotist, but this is by no means the case. The subject always more or less resists the suggestions given to him, even though he may carry out the commands of the hypnotizer. "Blind, automatic obedience of the hypnotized is never complete; suggestion always has its limits, which are sometimes wider and sometimes narrower, and may vary considerably in the same individual." The hypnotized person always protects himself by autosuggestion. For example, if his arm is lifted, and if he is told that it is stiff, he subconsciously disbelieves it. For he struggles to lower it, strains vigorously, and may ultimately succeed. It takes some strong, additional countersuggestion to induce him to let the arm remain in the air. The hypnotizer may have to say: "I lift your arm into the air by means of a magnetic force too strong for you to overcome." So we see the resistance is present in spite of the suggestion. It is also commonly thought that the hypnotized person will carry out, even though resisting, any kind of suggestion which is made to him. It is a fundamental error to believe this. For while there are cases of hypnotized persons who have carried out criminal suggestions, it is believed by the best authorities that such actions were not due nearly so much to the hypnotizer as to the presence of unconscious criminal tendencies in the subject which were only waiting for the right cue to be turned into action.

SUBNORMAL TYPES, AS INDICATED BY FEATURES AND FACIAL EXPRESSION



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BLENDING TWO PICTURES INTO ONE—A TRICK OF VISION

Furthermore, the influence of the hypnotizer often diminishes with practice upon the same subject. The hypnotized gets to know his hypnotist so well that the fascination is gradually lost, while his own auto- and contrary-suggestion increase. The hypnotist has more power over his subject the less frequently he deals with him, and care must be taken not to give the suggestions either mechanically or always in the same way. Changes in the subject's mood also make it harder for him to be hypnotized. Besides, if the hypnotist has failed several times with the same person to have his suggestions carried out, it is very difficult for him to gain the upper hand later. The subject's confidence must be carefully preserved and educated, else the very sensitive relation between the two persons will not be maintained. The subject's suggestibility may be destroyed at one stroke by mistrust or ill humor, by idiotic deceptions, or absurdities on the part of the hypnotizer. Trust, confidence, and belief on the part of the hypnotized, and delicate skill and ingenuity on the part of the hypnotizer, are equally important for success.

To give a full and complete explanation of all the phenomena of suggestion and hypnotism would not only be very difficult, but it would also take more space than these pages allow. Nevertheless, there is a very common physiological principle to which we can safely refer for all true explanations of these various and remarkable phenomena. We mean the principle of the "conditioned reflex," which, as has already been shown, underlies habit, association, and memory. The principle is that if a novel stimulus is yoked with one that is familiar, we may eventually confer on the novel stimulus much of the efficiency

which formerly belonged to the familiar one. The sound of the dinner bell makes us feel hungry, the sight of the postman induces the longing to hear from our absent friends, and the appearance of a circus parade makes us remember long-forgotten events and scenes of our childhood. In all these cases the associated stimulus is the condition for the reappearance of thoughts and feelings which had long been in the background of our minds.

Dr. Percy Stiles in his book, "The Nervous System and its Conservation," thus speaks of the relationship between hypnosis and the "conditioned reflex": "Have we not here something directly related to the mysterious *rapport* of hypnotism? It seems strange that a human subject can become indifferent to all voices save one and yield abject obedience to that controlling voice. But it may be conceived that this is only an elaborate development of the conditioned reflex. When the hypnotic state was induced the nervous system became attuned to the particular pitch and timbre of the speaker's tones." In other words, when the two persons, the hypnotizer and the subject, agreed to cooperate in producing a trance, the subject's very act of consent involved the establishment of thousands of conditioned reflexes for the activation of which the hypnotist's voice became the novel or *conditioning* stimulus. The same thing of course happens to a more or less degree in all cases of suggestibility. Even the approach of a messenger boy bearing a telegram *sets* many people to hear disquieting news. In hypnotism the *setting* is complete, while the semisleeping state with which hypnosis begins inhibits the normal countersuggestions from blocking the commands which are given by the hypnotizer and carried out by the subject.

CHAPTER XXXI

THE MIND OF THE CROWD

ON the night of April 14, 1865, Abraham Lincoln was assassinated. Two hours after the fatal shot was fired a huge and excitable crowd filled Madison Square, in New York, and threatened every moment to become wild and unmanageable. Traffic was stopped, the police were helpless, and it would have taken only a suggestion to turn the great, jostling, hoarsely shouting throng into a terrible engine of destruction. Suddenly a balcony window opened above the square, and a tall and erect man of commanding presence appeared, with face strangely calm and hand uplifted. The crowd barked, cheered, and then grew silent in the presence of this leader of men. It was General James A. Garfield. Still calm, still with hand uplifted, and with a voice of invincible persuasion he spoke these words: "Fellow citizens, clouds and darkness are around Him; His pavilion is dark waters and thick clouds; justice and judgment are the establishment of His throne; mercy and truth shall go before His face. Fellow citizens, God reigns, and the government at Washington lives!" The effect was electrical. The crowd listened, cheered, began to sing, and quietly dispersed to their homes.

As long as the planet is inhabited so long will there be crowds; and as long as crowds gather either on a bathing beach or at a fire in the night the law

of the crowd mind will operate to shape men's thoughts and sway their emotions.

For whenever a crowd collects, the psychological law of the crowd mind begins to regulate every member of the crowd. It dominates him utterly, molds him, alters his ideas and his feelings, until finally he is often so changed as to be quite a stranger to himself. We are ruled by this law more or less every time we go to the theater, or into the dense jam of people in a street car, or into the department store on bargain days. We also tend to be swayed by this influence while watching a Fourth of July or a Labor Day parade, for even though we may be merely spectators, once we give ourselves over to the shouting and the enthusiasm we have suddenly lost ourselves and become a part of the crowd in the street below us. This law works in all places without fail—all places but one, and that place is our own home and fireside. There we remain ourselves. The walls of the house and the associations of the home protect us. But once we step out of our own door and mingle with the multitude, the law of the crowd obtains control over nearly all we do or think.

What is this psychological law of crowds? What is it that gets such complete control over the multitude as to transform each and all of its members—that makes them so slow to reason and so quick to act, so tender one moment and so destructive the next? Let us see.

First, there is the great number of people. Numbers mean power, strength, and might. They evoke a subconscious feeling of greater ability in every member of the crowd which all seem to share. Second, the members of the crowd are usually strangers

to one another. This adds a touch of uncertainty, a feeling more or less mysterious which sharpens the imagination. Third, there is a certain amount of restlessness which is very contagious. Each man in the crowd is keyed up, set on edge to know what is going to happen. And the denser the crowd becomes, the more this restlessness takes the form of wondering "How am I going to get out of this?" A fourth item is the increased suggestibility which everyone in the crowd shows. Everything he sees or hears is exaggerated and magnified. He wonders so much what other people are thinking and doing that he has no energy left with which to think or feel clearly with regard to himself. Gradually his own personality becomes lost. He no longer says or thinks "I," but only "We." This, then, is the law of the crowd, that with an increase in numbers there is an increase in wonderment, uncertainty, and suggestibility in each member of the crowd, with a corresponding decrease of personality, intelligence, and individuality. The influence of the crowd is to reduce us all to our second-best selves. The crowd becomes a mere mass of strength guided by any impulse that is shared by the majority. In each man hidden motives, subconscious desires, and unsuspected cravings arise and dominate, until he becomes lost and absorbed in the multitude about him. Hear what the French psychologist Le Bon says of crowds:

"We see, then, that the disappearance of the conscious personality, the predominance of the unconscious personality, the turning by means of suggestion and contagion of feelings and ideas in an identical direction, the tendency to immediately transform the suggested ideas into acts; these, we

see, are the principal characteristics of the individual forming part of a crowd. He is no longer himself, but has become an automaton who has ceased to be guided by his will.

"Moreover, by the mere fact that he forms part of an organized crowd, a man descends several rungs in the ladder of civilization. Isolated, he may be a cultivated individual; in a crowd he is a barbarian—that is, a creature acting by instinct. He possesses the spontaneity, the violence, the ferocity, and also the enthusiasm and heroism of primitive beings, whom he further tends to resemble by the facility with which he allows himself to be impressed by words and images—which would be entirely without action on each of the isolated individuals composing the crowd—and to be induced to commit acts contrary to his most obvious interests and his best known habits. An individual in a crowd is a grain of sand amid other grains of sand, which the wind stirs up at will."

A crowd may be either heroic or criminal, or both, depending upon what event it is watching or by what sort of leaders it is moved or swayed. The Crusades were examples of heroic crowds, welded together by religious zeal for the purpose of rescuing the true cross from the Saracens. The French Revolution, which caused rivers of blood to flow through the sewers of Paris, was produced by crowds sometimes heroic, sometimes criminal, and sometimes both. A jury is a crowd, especially when in the jury room, where often the verdict depends on how stubborn or how excitable one of the jurymen can become. An army in battle is a crowd, especially in a bloody conflict, where the fighting becomes a matter of each man for himself. Here many a sol-

dier is far more heroic because others are looking on than he could ever be by himself with a solitary foe. It takes the numbers, the noise, the contagion, the cheering, the suggestion, the arousal of hidden ambitions to produce the act of deathless heroism. After the fray the most intrepid hero will calm down to the same shy, bashful youth he was before. At a baseball game in the ninth inning, with the score a tie, two strikes and the bases full, the most staid, dignified, and Christian gentlemen often become frantic with excitement and agony. They howl, they cry, they groan; they clench their fists and become pale with expectancy or purple with rage. If you were to show the same people on the following day pictures of how they looked at the ball game they would scarcely recognize themselves. But this is not strange when we remember that by the law of the crowd each man is reduced to his second-best self. And since that self was not clearly apprehended while he was swayed by the sentiments of the crowd, is it strange that he should not own up to it afterward?

One need only watch a midnight crowd at a great fire to see in how short a time the whole panorama of human emotions may be displayed. Night with its darkness adds a subtle touch to the whole drama, while from the lurid flames the impulsive and suggestible onlooker can often draw many hints for his fancy. Such a crowd, especially when a woman or child is being rescued from a burning hotel, may show equally all the tenderness and all the intolerance of which its individual members are capable. It is restless and irritable. It often sways visibly as one man in sympathy with the movements of the rescuer. It is credulous, and believes its own illu-

sions in the face of all proof to the contrary. Up to the last possible moment it never doubts that the rescue which it has wished for will be accomplished. It is intolerant of failure, and would many a time do bodily harm to a fireman who had failed in his attempts, in spite of the fact that it had cheered the same fireman a moment ago till it was hoarse. Such a crowd is also dictatorial, and roars its commands as if all the authority of the human race were behind them.

The extent to which a crowd can become suggestible is almost without limit. A practical joker once stopped in the middle of a New York street, knelt down and began to peer excitedly through the slot of the trolley line, and remained kneeling and watching as if something which fascinated him were going on below the street. Soon one or two persons paused, turned, and began to imitate his curiosity. In no time a crowd of considerable proportions had assembled, which was presently so greatly augmented as to become little less than a mob, each member of which kept pushing in toward the center to see what it was all about. It took the police to disperse the crowd and to remove the practical joker to a place of safety. Every street faker makes the same capital out of the curiosity of his fellow men. Let him but display some new kind of sleight-of-hand trick, or start whispering a pretended secret to a bystander, and a hundred onlookers are soon crowding in to see.

Often the suggestibility of a crowd becomes so great and so thoroughgoing as to produce not only illusion but hallucination. It sees what is not really there, hears sounds which were never made or uttered, calls black white, and white some other color. Le Bon narrates an unusual collective hallucination:

"The frigate, the Belle Poule, was cruising in the open sea for the purpose of finding the cruiser Le Berceau, from which she had been separated by a violent storm. It was broad daylight and in full sunshine. Suddenly the watch signaled a disabled vessel; the crew looked in the direction signaled, and everyone, officers and sailors, clearly perceived a raft covered with men towed by boats which were displaying signals of distress. Yet this was nothing more than a collective hallucination. Admiral Desfosses lowered a boat to go to the rescue of the wrecked sailors. On nearing the object sighted, the sailors and officers on board the boat 'saw masses of men in motion, stretching out their hands, and heard the dull and confused noise of a great number of voices.' When the object was reached those in the boat found themselves simply and solely in the presence of a few branches of trees covered with leaves that had been swept out from the neighboring coast. Before evidence so palpable the hallucination vanished."

It is a fascinating psychological question whether a crowd in the moment of its greatest excitement and suggestibility should be called legally or morally guilty of its acts. For since no single individual in a crowd can be said to be intending what the crowd as a whole accomplishes, he is hardly guilty before the law of the actions he unwittingly helps to further. The law deals only with individuals and with their guilt, while the crowd is a sort of composite human being, a many-headed and many-handed monster. Hence, even though the crowd as a whole may do damage or even commit murder, from the point of view of the psychologist, it is hardly true that when the police arrest the ring-

leaders, they have apprehended the motive force which led to violence. The fact that a crowd is capable of both the tenderest and the most violent feelings makes it doubly hard to answer this question which we have put. Shall we say that it is insane in its anger and sane only when it is merciful? Is it composed of the better selves of its members when it is kindly disposed, and of their worse selves when it frets and roars its disapproval? These are difficult questions whose answer lies beyond the scope of this book.

Le Bon says:

"A crowd may be guilty of murder, incendiarism, and every kind of crime, but it is also capable of very lofty acts of devotion, sacrifice, and disinterestedness, of acts much loftier indeed than those of which the isolated individual is capable. Appeals to sentiments of glory, honor, and patriotism are particularly likely to influence the individual forming part of the crowd, and often to the extent of obtaining from him the sacrifice of his life. History is rich in examples analogous to those furnished by the crusaders and the volunteers of 1793. Collectivities alone are capable of great disinterestedness and great devotion. How numerous are the crowds that have heroically faced death for beliefs, ideas, and phrases that they scarcely understood! The crowds that go on strike do so far more in obedience to an order than to obtain an increase of the slender salary with which they make shift. Personal interest is very rarely a powerful motive force with crowds, while it is almost the exclusive motive of the conduct of the isolated individual. It is assuredly not self-interest that has guided crowds in so many wars, incomprehensible as a rule to their intelligence

—wars in which they have allowed themselves to be massacred as easily as the larks hypnotized by the mirror of the hunter.

"Even in the case of absolute scoundrels it often happens that the mere fact of their being in a crowd endows them for the moment with very strict principles of morality. Taine calls attention to the fact that the perpetrators of the September Massacres deposited on the table of the committees the pocket-books and jewels they had found on their victims, and with which they could easily have been able to make away. The howling, swarming, ragged crowd which invaded the Tuileries during the Revolution of 1848 did not lay hands on any of the objects that excited its astonishment, any one of which would have meant bread for many days."

How is the imagination of a crowd impressed? It is not by attempting to work upon its intelligence, or by appealing to its reason, or by any such method as a scientist employs in his careful demonstrations of fact and truth. "It was not by cunning rhetoric that Antony succeeded in making the populace rise against the murderers of Cæsar; it was by reading his will to the multitude and pointing to his corpse." It is the emotions of the crowd and those alone upon which the orator always works.

"See what a rent the envious Casca made," says Mark Antony, and by this one word "envious" he stirs up more sympathy for Cæsar than he could have done by enumerating all of his exploits and his virtues.

It is easy to see that all ideas accepted by a crowd must be expressed in simple, direct, and emotional language. What a crowd lacks in critical ability, it attempts to make up for in increased capacity for

emotional excitement. Slogans are especially effective for arousing the feelings of a multitude, for the reason that slogans are usually short enough to be grasped quickly, and require no repetitions to be learned by heart. Besides, slogans are all positive; they are always couched in the language of affirmation, never in the language of doubt. They evoke strong and permanent images, compel immediate belief, and seem to each man in the crowd to express clearly what he was unable to say for himself. Startling and picturesque examples also serve the same purpose. The loss of the Titanic and the Lusitania accounted for the death of only a few of the persons who perished at sea during the past few years; but on account of the spectacular nature of these shipwrecks, they are almost the only ones the average man remembers or feels keenly about. The "Charge of the Light Brigade" was a much less bloody event than many an engagement in the Civil War, but the poet Tennyson has embellished it with such vivid images that it stands out in some people's minds as the most forlorn hope in history.

The nature of the crowd mind can best be comprehended by recalling what sort of men make the best crowd leaders, and what sort of persuasions they use to convince and rouse their followers. Of course some crowds do not have real leaders in the common meaning of the word, but even so, the more excited any crowd becomes, the more do its front ranks tend to be filled with those men whom nature has fitted to be its masters. What are such men like? They are not necessarily the tallest men in the crowd, nor the most intelligent. Neither are they fat men, for fat men never made or led a mob. This is not because fat men find it hard to keep up with the

speed of a crowd, nor because they are afraid of being squeezed, but simply for the reason that their temperament and emotional nature forbid it. The natural-born leaders of crowds are usually small and nervously excitable men, quick to think and act, despotic, convincing, and fiery. They affirm, they repeat, they demand "yes" or "no" in answer to their questions, and make their excitement, their grudges, or their motives contagious by sheer determination. Otherwise, and especially when the crowd is more or less controlled and quiet, as in a large auditorium, the factor of prestige is especially powerful to give a man leadership over it. Military uniforms, the exploits of a hero or an adventurer, fame and reputation, all work to the same end. The crowd loves to admire, and will not often discriminate between what is worthy of praise and what is not.

Before leaving this subject it is well to remember that a large part of the history of civilization is the history of crowds. What men have fought for in battle and worked to achieve in peace is chiefly what the leaders of crowds have held up to them as the goal of success. Our customs, our traditions, and our institutions are all supported upon the beliefs of the crowd—that is, upon what the great mass of men have been encouraged to defend and to achieve. It is easy, then, to see that all of the beneficent changes which have come in the customs and traditions of the world must necessarily have originated not in crowds, but through the influence of single, heroic individuals. To be convinced of this, one need only recollect that the great events in history are events in the lives of individual heroes, and that the great discoveries in science and invention were made by men who worked in solitude.

CHAPTER XXXII

SALESMANSHIP

THE psychology of salesmanship is chiefly concerned with two things—the mental equipment of the salesman and the interaction between the salesman and the buyer. A proper understanding of these two things has been found by successful salesmen to be of unusual advantage in their work.

By the mental equipment of the salesman is understood (1) his knowledge of his goods, (2) his attitude toward his work, and (3) the methods by which he aims to effect a sale. Let us briefly consider these three factors in order.

To be successful, a salesman must know all about his goods. If they be manufactured articles, he must be acquainted with the source of the material and the process of manufacture, and he must know the plain use as well as the special advantages of what he is selling, besides much other related information. Why? Because it has been the experience of every young traveling salesman that no sooner had he started on the road than he failed to close a sale with a prospective buyer because he was not sufficiently informed about his wares. The prospect had been interested at once in the article for sale, but his interest had revolved about a certain feature of the article which the salesman had neglected to consider in sufficient detail. The result was that the salesman, in not being able to answer the buyer's ques-

tion, had nothing wherewith to encourage and develop the interest of the prospect. That interest forthwith sickened and died. In vain the salesman pointed out alternative features, for though they were all pertinent to the article, they were not pertinent to the prospective buyer, whose special sentiment the salesman was unable to appreciate.

From this it can be readily seen that the salesman's knowledge of his goods involves much more than their price and catalogue number. One sees the appalling lack of salesmanship in the modern department store, where many of the salespeople might as well be replaced by slot machines. The kind of knowledge here meant is a mixture of imagination and empathy—the ability to grasp quickly the dominant interest in the minds of others, and the skill to assume that interest for the time being and develop it. This fertility of imagination every competent salesman possesses. He was not born with it, but he acquired it by the very simple method of always studying his goods in relation to the human needs which they were supposed to satisfy. Moreover, he has welcomed every opportunity to expand the range of his associations by contact with other people, and by consulting their interests and preferences. The successful salesman is equipped not only with the knowledge of how his goods are manufactured; he is also equipped with a knowledge of the myriad sentiments which actuate people to want things and to buy them.

The second factor in the salesman's mental equipment—his attitude toward his work—is a very elaborate sentiment centered about his goods and his customers. To develop and fortify this sentiment becomes his chief concern. The good salesman

knows very well that the time he spends with himself is just as important as the time he spends with his prospect and that the success of his encounter with his prospect depends upon the extent to which he is prepared for this encounter. This factor involves a decided advance over the first one. It is not enough for the salesman to know his goods, since a stock clerk can do that; neither is it sufficient to know that minds and interests and sentiments differ more than it is possible to predict in advance. The salesman's own preparation involves the building up of a sturdy and unwavering confidence in his goods and in his ability to sell them. The new psychological factors here involved, especially in the case of the novice, are largely factors of autosuggestion. You remember the first lines of Walt Whitman's "Song of Myself"—"I celebrate myself and sing myself," by which he meant to make up for the praise and encouragement that others might be slow to accord him. Well, the beginning salesman has to do pretty much the same thing; he practically has to announce his success long before it has arrived, and even reiterate this announcement in opposition to his first dozen failures. Indeed, autosuggestion is the only means by which the salesman can steady himself during the crucial period of his apprenticeship. He will meet indifferent people, bored people, people older than himself who immediately discount his statements on the basis of his youthfulness, as well as people who have had an unsatisfactory experience with the article he has to sell at the hands of a previous salesman. All this influence he will have to counteract by the uninterrupted iteration of his own ability to "put the deal across."

It is the peculiar business of applied psychology to furnish a valuable weapon wherewith to conquer discouragement. Many a salesman, after wasting his sweetness on the desert air of negative prospects, retires to his room at night, to go over the day's discouragements in muddled detail and iteration, until he finally falls asleep from sheer exhaustion. Neither does the morning find him refreshed, but all through the succeeding day his face looks failure before he has uttered a single word. Now discouragement, however much of a "mental" quality it may seem to be, is fundamentally a posture of the body, centering in the muscles of facial expression and the muscles of the neck and back. You can get the feeling of dejection at once by putting your body into the appropriate droop; indeed, you can get such a feeling more readily by this means than you can by merely conjuring up visual images of some heartbreaking scene. Contrariwise, if you stiffen your spine, and wreathe your face in smiles, you cannot feel dejected. A valuable hint lies in the knowledge of these facts. For the salesman gets discouraged principally because he has allowed his neck to bend, his jaw to droop, his eye to slacken its alertness, and his voice to decline in pitch and firmness. Such a posture of dejection cannot long attach to the body of a man who has trained the muscles of his face and neck to habits of flexibility. For anyone can observe it in himself that the feeling of dejection always accompanies chronic tensions in the facial muscles.

Moreover, for autosuggestion to be most effective, it must produce an immediate change in the bodily attitude. It does no good at all to keep repeating assurances of success while at the same time the

chronic tensions are not replaced by a condition of muscular flexibility. For the autosuggestion, "Success is assured to me," must produce a dynamic effect in the face and voice of the salesman before it can sway the prospective customer. Otherwise, the effect of autosuggestion is complete self-deception. For the oftener the verbal encouragement is not followed by the change in visible appearance and attitude, the sooner will this discrepancy become habitual. Moreover, there is nothing to be gained and much to be lost by thus "bearing false witness" against oneself.

Much more, however, remains to be said about the necessity of removing this feeling of discouragement. For it is plain from what was said in the chapter on instinct, that the posture of dejection is a withdrawing reaction. It will also be recalled that all withdrawing reactions fail to release as much energy as is compatible with the most normal functioning of the human body. Moreover, the posture of dejection, like the frown on the countenance, is productive of more muscular fatigue than is the posture of confidence or the smile. To put it briefly, discouragement poisons the whole system. Nevertheless, even in this extremity there are hopeful signs to be detected. For the fatigue poisons themselves act as a stimulant, driving us abroad and afar in search of different environments, new faces, and other minds, with the result that we are rested either by the exercise we take or the change of scene we experience at the end of our journey. Figuratively speaking, fatigue causes the kinetic system to desire a change of activity. It is weary of expending so much energy to produce chronic tensions. Hence it is that even the verbal autosuggestions of en-

couragement that we murmur, if followed by the return of flexibility to the muscles of facial expression, will produce just the right condition for the beginning of a different sort of kinetic activity. The old adage, "Hope springs eternal in the human breast," means exactly this, that man's body is so organized as to be unable to maintain the posture of dejection beyond a certain limit. When that limit is reached, fatigue poisons accumulate and drive us to perform other activities that gradually restore our minds to normal.

And yet a very serious question may arise in some minds as to whether they can use this information to their own profit. They may admit that it is true, and may see exactly how it suits their case; but for all that tney will still be unable to throw off their discouragement. And while it is regrettable that there are persons to whom knowledge is not power, nevertheless, we offer the following additional hints as a last desperate attempt to provide the remedy sought:

(1) Take regular exercise of a type exactly suited to your body, in order to keep all the muscles under the control of your suggestions. Muscular agility helps in two ways to prevent discouragement. It enables any set of muscles to be used when desired, and it also promotes good digestion, thereby increasing the rapidity with which fatigue poisons are carried off. Much pessimism is simply sour stomach and auto-intoxication which regular habits of exercise will readily abort.

(2) Cultivate the habit of relaxing your body thoroughly whenever you are given an opportunity to rest. Study your jaw, your neck, your hands, your back, in order to see how much needless tension

they accumulate and prolong. The habit of muscular relaxation is often unconsciously practiced by business men when they pause in their work to exchange droll stories. In one city where the movies are open from 11 A. M. to 11 P. M. it is the custom of canvassers and bill collectors, after they have had a run of bad luck, to watch the screen for an hour in order to get their minds off their troubles. This is excellent applied psychology.

(3) Analyze the cause of your mistakes and failures rather than simply regard them with self-pity and fear. It is perhaps far more difficult to profit by this suggestion than by the other two for the reason that it requires a singular degree of intelligence to analyze one's own mistakes. But the wise salesman will be willing to say: "I admit that I fell down in that interview, but I am going to find out why." And at that very moment he will begin to profit by, rather than suffer from, his mistakes. For he will start to shift the emphasis away from the less important matter, his feelings, to the more important matter—the *cause* of his failures.

The third factor in the salesman's equipment—the method by which he aims to effect a sale—may be treated of here in terms of his selling talk. The art of selling is largely the art of conversation, and I take it that the same principles underlie success in both these activities. And just as neither browbeating nor obsequiousness factor in a profitable conversation, it is hardly likely that they are of any avail in selling. The able salesman uses neither. His chief business is to make contagious his own interest in the value of his product. Neither begging nor bullying will succeed in accomplishing this end. Sometimes it is supposed that this contagion must be

produced by taking an unfair advantage of the prospect, but this is by no means the case. It does not require an appeal to the pride of the prospect, nor does it involve making him commit himself in an unguarded moment to a judgment that he will sooner or later regret. Things sold well not only stay sold, but they automatically generate those two most precious of business assets—the confidence of the buyer in the salesman, and the confidence of the buyer in his own ability to judge and choose values.

In order for the salesman to make contagious his interest in the value of his goods, the interest must be genuine, permanent, and absorbing. A "faked" interest will not do, since sooner or later the forcing process that keeps it alive will become apparent. Neither has such a faked interest anything to offer in the way of encouragement during the salesman's "off-days." It is always a dangerous liability. Moreover, the salesman who can develop a permanent, genuine, and absorbing interest in his goods will soon discover that only a certain excellent quality of goods can generate and maintain such an interest. For example, if a man who sells smokers' supplies feels that the Dunhill pipes are the only ones that do not have to be broken in, but which give you warm mouthfuls of well-tempered smoke from the first puff, he cannot extol any other grade or variety of pipes to his customers without having the secret wish to add, "But between you and me, get a Dunhill." In other words, the salesman's deepest sentiment, the inevitable activities of his kinetic system, will hinder his ultimate success in selling anything but those goods about which his beliefs automatically cluster.

From this it is plain that the successful selling talk is nothing that one man can write for another, or that can be learned by rote. It must come automatically from the salesman's genuine interest in the value of his goods. Neither can it be stereotyped, for since the first aim of the salesman is to connect with the sentiments of the buyer, his selling talk must be kept fluid enough to be constantly remodeled to suit the varying needs of the moment.

With this we pass from the salesman's equipment to the interaction between the salesman and the buyer. But it can easily be observed that in outlining the first of these topics we have already written much that applies as well to the second. Moreover, in attempting any elaboration of the second topic, we should have to cite numerous individual cases in order to show exactly where, in the dramatic incidents known as sales, the rise and fall of the salesman's fortunes occurred. This is too extensive a task to be attempted here. Nevertheless, it can be safely assumed that he who ponders the art of the salesman's preparation as we have hitherto outlined it will have gone very far in the discovery of those factors which, in the actual dramatics of the selling game, have brought success to the most able exponents of the art. For it is from watching and talking with such men, rather than from reading the dozens of pseudoscientific books on the subject, that the material of this chapter has been secured.

CHAPTER XXXIII

ADVERTISING

THE business of advertising has become so vast in scope and so complicated in its details as to require long study and longer practice on the part of anyone who wishes to know it from the inside. Consequently, any attempt to give a comprehensive view of it in so brief a space as this would be futile. Its history, its present trend, the theory of it, its value in dollars and cents, its methods, as well as its defects, are topics which any student of the art finds at once both fascinating and extensive. Moreover, advertising, like any other activity of the business world, has to-day become so specialized that a man familiar and adept in one kind of advertising is more or less a stranger to another kind. Taking all these facts into consideration, it is well-nigh impossible for a full account of the psychology of advertising to be written, for the very good reason that the art is progressing faster than it could be recorded. One has only to read books on the subject to see how stale they have become six months after their date of publication.

Nevertheless, all advertising whatever is fundamentally a psychological phenomenon. For however the advertiser states his purpose—getting the attention of the public, awakening their interest, stimulating their desires, or making sales—in all this he is simply employing a stimulus to produce a

response. He wants people to do certain things, and he proceeds to besiege their eyes and ears, their noses, tongues, and skin with what he considers to be the most motivating stimuli at his disposal. Indeed, today the professional advertiser is in many ways a thoroughgoing experimental psychologist, whose laboratory is the whole out-of-doors.

Let us here consider three of the most important psychological phenomena with which the advertiser has to deal, namely, attention, empathy, and the conditioned reflex.

Experiment has shown that in general the attention is aroused by intensity, size, contrast, and change. Loud sounds, bright lights, and strong odors force themselves upon us, while less intense stimuli fail to arouse our notice. The effect of contrast "may be seen from the fact that a fairly bright light in the dark attracts as much attention as a brilliant light in full daylight, or a light footstep in the silence of the night as much as the automobile horn in the midst of a dense street traffic." That change is an essential element in arousing attention is illustrated by the fact that constant sunlight goes unnoticed, while the shadow cast by a passing cloud is at once observed. "The miller is oblivious to the sound of his mill, but the slightest change induced by a defect will at once be observed." Furthermore, "the decrease in the size of an object moving directly away from us attracts attention almost as certainly as does the increase in size due to its approach." The advertiser makes full use of the above knowledge. The large electric display signs that flash on and off in the night illustrate all of these principles for the getting of the attention of the passer-by. Of course, with every different medium which the advertiser

uses, a slightly different method of applying these principles is involved. However, it must be borne in mind that the phenomenon of attention is by no means a function of the sense organs alone. For even though intensity, size, contrast, and change are highly essential to consider, equally important things are still to be mentioned. When I see an electric display sign whereon there appears to be written out as I gaze at it some advertising slogan, far more than the eye is involved in this perception. For step by step the motor mechanism of the eye as well as of the hand follows the motions on the sign, beginning where they begin, and ending where they terminate. The advertiser has succeeded in getting my attention not merely because his sign is large or bright, but rather because he has thus directed my responses and controlled the flow of my energy in a certain precise manner. But even this is not all that attention in this instance means. For we attend only to those things in which we are for some reason interested. Now interest, as we have hitherto shown, is another name for sentiment (taken in its broadest signification) and all sentiments whatsoever are due to the activity of the greatest going concern of the whole body—the kinetic system. Indeed, our superficial sense organs—the eye, ear, nose, etc.—attend to nothing by themselves. Attention is organic—that is—it is really a function of the whole body. Hence it would seem that the eye can be effectively attracted only by advertisements which are so constructed as to awaken some one of our dominating desires. This is exactly what is meant by writers on the theory of advertising when they speak of the importance of considering human instincts in framing an advertisement.

See, now, just how precisely this principle works out. The appeal of the maker of medicines, soaps, underwear, food, corsets, and a dozen other familiar articles stresses today their *health-giving* qualities, even as much as he emphasizes their esthetic qualities. Stationery is advertised not only as durable, but also on the basis of its appeal to the self-love and social ambitions of the correspondent. The safety-razor advertisements appeal to the desire to have a comfortable and painless shave, and to start the day with an unruffled mind. Indeed, no article of commerce that is advertised to-day can be successfully promoted without the consideration of the factor of sentiment. And we attend to an advertisement chiefly because this sort of an appeal is fundamental. Our senses always do our body's bidding.

The second important psychological phenomenon which the successful advertiser takes into consideration is *empathy*. This mental function has been already illustrated for us in the case of the electric sign on which words seem to be in the process of being written out. Our imitative responses in following such a movement are called empathy. The same empathic responses take place when a display sign represents the emptying or filling of a bottle, the drinking out of a glass, hands clasped and shaken, a hand reaching out for a pen, or any other similar activity that we tend to imitate. The advertisement of the comfortable chair in which we tend to imagine ourselves lounging, the tobacco advertisements that show a placid or fervent smoker, the representations of serious fires averted by the use of a patent extinguisher, and similar devices all produce imitative or empathic responses in the attentive observer.

The chief means used by the advertiser for producing such imitative activities in us is *naturalness* in the portrayal of the illustrated event. The lounger in the velvet arm chair is shown peacefully relaxed. Were he stiff of knee, or sitting bolt upright as if he were apprehensive of a bent pin beneath him, the empathic effect would be lost. The smile of the pleased tobacco smoker is a smile of intelligent contentment rather than of either irony or imbecility. And so on throughout all other similar devices for stimulating the public to buy the goods. Here it is where the skill of the designing artist comes chiefly into play. He knows that only the precise study of how people look and act will enable him to portray their sentiments. For himself, he must be sufficiently empathic in order to imagine the look and gesture of the satisfied or interested customer.

Now just what is accomplished by the production of empathic responses in the reader of advertisements? The answer is that when we are empathic, our nervous energy is being released in such a manner as to involve more and more of our minds in the object stimulating us. We tend to yield so completely to the suggestion of the advertiser that what the advertisement says we believe. For that which controls the output of our nervous energy also controls our minds. Moreover, empathic responses always take a certain length of time to rise and to fade out, and this interval is quite sufficient to establish those clear first impressions which we have already found so valuable in making things remembered. Those things to which our whole mind is devoted, even for a brief three seconds, are not easy to lose or to efface.

The third psychological phenomenon which the advertiser considers is the *conditioned reflex.* The nervous system is so organized as to make it possible for the same reaction to be evoked by any one of several stimuli that have occurred frequently together.

As explained before, habit and association are both due to the establishment of conditioned reflexes. The advertiser, in seeking to make the public always remember to purchase his particular brand of goods, employs devices whereby to fix conditioned reflexes in their minds. Take a well-advertised soap, for example, whose trade-mark is stamped on the cake. When I wash my hands with it, two stimuli are simultaneously affecting my eyes —the shape of the cake and the name of the brand. Now, just as at the sight of any soap one is tempted to think of washing, so it comes about that the shape of the cake and the name of the brand can gradually evoke the same tendency to action. The inessential has gradually become the essential. Hence it is that the name of the brand can thus be made to determine or condition the washing reaction. And, to make a long story less tedious, all advertising of trade-marks and brands is an attempt to establish conditioned reflexes in the public.

It is obvious, however, that, since merely the *repetition* of the same trade-mark is not a device whereby the attention may be everlastingly maintained, the successful advertiser has to devise constantly new settings in which the trade-mark can be exhibited without its becoming monotonous. Here again the skill of the designer and the flexibility and fertility of his imagination must help the advertiser out of the difficulty.

It is a common saying that advertisements are "silent salesmen." But it is just as appropriate to say that the goods advertise themselves. For just as an advertisement may influence one to buy, so, on the contrary, it may come to pass that the goods bought may influence the purchaser never to buy them again. Advertising, therefore, is not necessarily synonymous with getting out printed matter or display signs. Moreover, the buyer equally well and often advertises his purchases to his fellows by praising or condemning them, and so it is plain that much advertising of an article is carried on by a medium totally beyond the control of the professional advertiser.

It is perhaps for this reason that the slogan "Tell the truth" has been adopted by the advertising fraternity. For since the success of a business venture is in the last analysis in the hands of the public, it has been wisely concluded that the public is the first, rather than the last, element to be considered by him who wishes to sell what he produces. Nevertheless, in the midst of violent competition and in the face of numerous complications and details, it is doubtful whether the slogan "Tell the truth" can be fully applied to the advertising business. For the business man is often so hemmed in by custom and necessity as to be all but unable to distinguish clearly between what is actually the case and what he would like it to be.

CHAPTER XXXIV

WIT AND HUMOR

IT is a classical distinction between wit and humor that in the case of the former we laugh *at*, while in the case of the latter we laugh *with*, the subject of the jest; but why we laugh at all, or what the laugh really is are questions which even the most serious-minded man is sorely tried to answer.

Recent investigations into the nature and workings of the mind, however, have revealed pretty clearly that wit and humor are due to influences arising in the subconscious or subterranean part of our personality. Deep in the abysses of our minds slumber and stir various impulses and wishes which, if unsuppressed, would result in all manner of startling remarks and actions. But through a long and tedious course of training in self-control and regard for others we have gradually been taught to keep these deeper, elemental wishes under restraint. This restraint is largely due to the habits of bodily action and facial expression which our elders have obliged us to acquire. It is a familiar experience to be either fearsome or "wiggly" way down inside, but to refuse to allow our face to become involved in the organic disturbance. As a consequence of our early training, we are enabled often for long periods of time to keep an unruffled countenance even in the midst of fear-provoking or mirth-provoking situations. But mark what this means: it

means that often at the same time the body's energy is being employed to maintain antagonistic reactions —the tendency to "let go," and the countertendency to be imperturbable.

But what does this tendency to "let go" imply? And what does it have to do with wit and humor? Simply this, that witty and humorous remarks are those which arouse a subconscious wish to overt fulfillment so suddenly as to evade this restraining power of the upper consciousness. It is "letting the cat out of the bag." The upper consciousness which stands as a vigilant censor over our actions has been tricked, and the result is that something we meant to suppress has been released.

And now what we shall have to say may strike some readers as being both hasty and inappropriate. Which is that both wit and humor have their origin in our dissatisfactions and in our ever vigilant desire to turn the tables on those who have been the cause of our dissatisfactions. We laugh to "get even" with those who once have had the best of us.

The German word *Schadenfreude* has no English equivalent, but it means the pleasure we get at another's misfortunes. *Schadenfreude,* then, is the fundamental factor in wit and humor. However, this mild form of malice can be directed at oneself, for most of us are many different personalities rather than a single soul.

Let us see how well this principle applies to a few obvious jokes. It does apply, I think, to such a pun as the following:

"My Lord, the Duke of Buckingham, waits without the portals."

"Then tell him to go back and get them!"

Although this particular joke is of the "stubborn" variety, and while it is hard to tell at just whom the *Schadenfreude* is most directed, yet the laugh doubtless arises from the consciousness that some one is more stupid than ourselves. Surely, the same pleasure in our own superiority accounts for the humor in the following anecdote of a negro dance:

"Hi say, Miss Mandy, am yo' program full?"

"Lawdy, Mister Lumley, hit takes mo' than one small sandwich and two olives to fill *mah* program."

The same principle seems to be exhibited by the next example:

"A visitor to an insane asylum was guided about by a trusty who to all appearance was as sane as anyone could wish. He explained lucidly all the various types of insanities, and showed an unusual familiarity with them. Finally the trusty and the visitor stopped at a room where a man who was suffering from religious delusions called out, "I'm Almighty God!" "Don't believe him," said the trusty quickly, *"I'm* Almighty God." The visitor made no immediate reply, but, being tactful in handling such people, engaged the man in conversation, and when well within sight of the main office, he confidentially inquired, "If you're Almighty God, I wish you would tell me the answer to a question that has long puzzled the wisest men. It says in the Bible that God made the world in six days. Now were those days twenty-four hours long or a thousand years, or, as some suppose, millions of ages in extent?" The trusty smiled indulgently at him. "Pardon me," he replied, "but I never talk shop."

Here there are plainly two, if not three, motives for laughter. In the first place, our sympathy with the insane tempts us to enjoy the sudden and com-

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TESTS IN INDUSTRIAL EFFICIENCY. At the left a young man is trying to hammer marks at equal distances apart; at the right is another test of muscular control [illegible] by tapping with a pencil on paper.

Copyright, Press Illustrating Co.

TESTING THE FIRMNESS OF THE HAND. Screws are inserted into holes of different sizes—always finding the hole instantly.

Copyright, Keystone View Co.

ANOTHER TEST FOR FIRMNESS OF HAND. The young man puts an electric needle into one hole after another. If he touches the sides, the needle makes a contact.

plete discomfiture of the visitor at the hands of the trusty; second, some enjoyment doubtless arises from witnessing the unblushing megalomania of both insane men, since any boast which we see to be groundless enables us to predict a future catastrophe for the person making it; while in the third place, anyone hearing the story may ridicule his own lack of good sense in hoping for a better ending to it.

Another story pointing the same psychological moral is that of the blithe, old, gossipy woman, all in all a dear, kind creature, who eagerly watched from behind her window blind the man going about with paper and pen enumerating the residents of the neighborhood. She was all excitement during the performance, and followed his going from door to door with keen curiosity and expectation. Finally, when she knew that her house was to be his next stop, she sprang to the door, and, opening it with alacrity, piped up in a quavering tone: "Be you the sensuous man?" It may require a good mimic to create the requisite humorous situation for this story, and even then the joke may fail. But I have heard at least one middle-aged man laugh uninterruptedly for more than a full minute in a public gathering at which this story was told, while other people in the audience sat as unmoved as sphinxes. "Clearly, then," writes Edwin Holt in "The Freudian Wish," "humor can generally be passed only among persons of similar suppressions ('prejudices'); and one notes, in fact, that it flows freely in circles of intimate friends, while it gives place to stiff formality in other assemblies in proportion to the lack of an established congeniality. The man who wants to be witty before a large audience must limit himself to

ventilating suppressions which are fairly common to the race. The safest way is to appeal to the Old Adam in us which secretly regards the fellow man as a rival and a prospective antagonist . . . . Even here the censors are of different degrees of strictness, and one must adapt one's *Schadenfreude* to the average censor of the audience. One person finds it excruciatingly funny to hear of a wan and lonely old woman sitting down on a tack; while another can scarcely bear to hear that Mr. X., the once promising but now middle-aged and disappointed senator, 'has a glorious future behind him.'"

Likewise a speaker, who should dare to tell a rural audience that "the reason why the air in the country is so pure is because the farmers keep their windows closed at night," would at once be accused, and rightly so, of a deliberate act of aggression against them. But even an audience in the coldest regions of the world might laugh unrestrained when told that "the ground there freezes so solidly that when anyone dies in the winter, they sharpen his feet and drive him into the ground with a pile-driver."

So much for a brief psychological analysis of wit and humor. It may not cover all possible cases, it is true, but surely it holds for the majority of jokes. And now we turn to a far more difficult question, namely, the significance of that bodily manifestation known as the laugh, or, when the laugh is wanting, the smile that takes its place. Of course, not every smile is of this variety, for there are at least a dozen different modifications of this general type of reaction, but our smiling at a witty jest surely needs some explanation.

"Laughter is an involuntary rhythmic contraction of certain respiratory muscles, accompanied usually by certain sounds." So far as the body is concerned, laughter betokens the presence of "an excess of energy above purely muscular needs." Dr. George W. Crile, from whose book "Man, an Adaptive Mechanism" these quotations are taken, has developed a kinetic theory of laughter, which, in part, is stated as follows: "Laughter excited by adequate stimulation of ticklish areas of the body is a recapitulation of ancestral struggles against the physical attack of biting and clawing foes on these parts. In other words, the laughter excited by tickling is *a substitute for the motor act of defense against injury*, and is a reaction imposed by the need for giving vent to the energy mobilized in the kinetic organs at the command of the phylogenetic stimulus. *The resultant action is purposeless, instead of purposive; but the result in the expenditure of energy is the same.* If the laughter excited be sufficiently intense or prolonged, the individual is as exhausted as if he had actually struggled with an enemy." So much for the mechanism of laughter provoked by tickling; it only remains to be shown that the tickle stimulus and the joke, in both producing laughter, act upon the organism in the same way.

There need, I think, be no doubt as to this identity. For just as tickle is a mild form of attack upon the body, so also is a joke. A joke is aimed to break down the censorship we hold over our suppressions. It is an attack upon the self-control of the listener, upon the barrier he has erected to defend himself against undue familiarities. This explanation will derive an unfailing support from those who must confess that their chief suppressions are connected with sex and

allied functions. "Every one of the causes of laughter, when analyzed, resolves itself into a stimulation to motor activity of some kind." For, to appreciate a joke, we must imaginatively take some active part in the witty situation, in other words, we must act *as if* the joke were played either *by* or *on* us. And all such emphatic response is accompanied by the mobilization and transformation of energy.

Crile further writes: "It is interesting to note that the respiratory system, principally, is utilized for the muscular clarifying purpose of laughter. Why are not other muscular portions of the body utilized? Why do we not laugh with our feet and hands as well? As a matter of fact, the by-products of excitation are often consumed in other motor acts than those accompanying laughter, as is shown often in public gatherings by the stamping of feet and clapping of hands of an audience excited or amused by the impassioned or humorous words of a speaker, or by the activations of enthusiastic spectators at a championship ball game. . . . To be a truly adaptive phenomenon, however, laughter must not seriously interfere with any other function. Were laughter expressed with the hand only, arboreal man might have fallen from the tree; and if expressed by the feet our equilibrium might be lost. Laughter, therefore, is expressed by means of a group of *powerful muscles which can be spared easily* without seriously interfering with the maintenance of posture or any other function. In order that the products of excitation may be quickly and completely consumed, the powerful group of expiratory muscles must have some resistance against which they can exert themselves strongly and at the same

time provide for adequate respiratory exchange. The intermittent closure of the epiglottis serves this purpose admirably, just as a horizontal bar affords the resistance against which the muscles of the athlete may be exercised."

If this explanation is correct, it is easy to see why the smile can be substituted for the laugh. For the muscles of facial expression can be spared for the purpose of transforming potential into kinetic energy as well, if not more easily, than can the muscles of respiration. And those people who react to a joke with only a smile, leer, smirk, or other fleeting grimace thereby show that the joke meant less to them—that is, released fewer suppressed wishes—than if it had involved them in paroxysms of mirth. One can also tell much of the subconscious life of an individual by noticing how much of his face is involved in his smile. For many people are so muscle-bound through unrelieved suppressions that only the upper lip or one side of the mouth is in any way relaxed in their response to a joke. The mental and even moral quality of a man can often be determined by as simple a touchstone as this.

CHAPTER XXXV

INDUSTRIAL PSYCHOLOGY

THERE is hardly any problem in industry, simple and easy of solution though it seems, that does not tax the last resources of the expert in applied psychology. The factory, the store, the office, the construction gang on the railroad, the stevedores on the wharf and in the hold of the ship, and every other like example of collective effort challenges the highest wisdom and solicits the utmost sympathy of anyone who attempts to solve the problems which constantly arise wherever individuals are brought and kept together. Some of the problems arise from the fact that different minds naturally work at different rates of speed, but are required to maintain a uniform pace; others are due to the differences and defects of memory; others to the fact that the *appointed* leaders of men lack the necessary qualifications; still others arise because the pressure of business competition destroys the insight into the means for securing cooperation; and so on through a long list of difficult questions, which year by year do not decrease either in number or importance. Let us see what sort of a solution the psychologist has to offer for some of the typical problems of industry.

One of the most heroic attempts along this line concerns the fitting of the worker and the job together. Formerly it was thought that the only safe

guide to follow was a man's physical size. "Let the big men shovel coal and chop wood, and the little men think," is still a fairly common way of treating the subject of vocational guidance or vocational engineering. Again, there is the equally unscientific notion that the job is fixed and unalterable, and that the worker is supposed to bend and shape himself accordingly. Recently, however, it has been recognized that both jobs and workers can be equally well adapted to each other—for example, that machines can be so constructed as to suit the human body, and also that human beings can with proper care adapt themselves to a great number of novel physical conditions. The principle of selecting both the job for the man and the man for the job at the same time works much better than the principle of regarding one or the other of these factors as obstinate.

A deplorable lack of sanity has, however, been recently shown by men who have assumed to give expert advice in vocational guidance on the basis of a uniform intelligence test. The difficulties of such a method are too numerous to give in detail, but suffice it to say that (1) such tests are invariably made by a man who has had no practical experience with the kind of intelligence he is supposed to be testing, and hence really knows nothing about how the worker's mind functions *while he is at work* in his job; (2) it is falsely assumed that a short verbal or manual test in the presence of only the examiner can reveal a man's aptitudes for work in the midst of noise or a crowd; and (3) the whole question of endurance—of a man's ability to keep doing well day after day—is ignored. Indeed, mental or intelligence tests, and, for that matter, trade tests, are

simply an indication of how hasty and careless we have become in our fitting of workers and jobs together. They merely indicate how little real care and human consideration we are now willing to give to one of the most complicated and irritating problems of industry. And, to cap the whole bad climax, we have to-day at least one self-styled efficiency expert who presumes to select factory workers on the basis of the color of their hair and eyes. Inspection of the great toe will doubtless figure prominently in the next stage of the development of this art.

The outstanding difficulty with all such methods is that the physiological and psychological factors of the worker are completely ignored. Not only are men modified by habit, but jobs are also modified by men. Men are dynamic agencies, not statues; and the prolonged influence of a group of other people upon them cannot be predicted by any offhand methods. Ponder now, my reader, especially if you live on one of "those vertical streets called an apartment house," the mental qualifications of a good janitor. What sort of a questionnaire would you devise for *your janitor* to fill out? Would you be satisfied to know his age, state of health, powers of arithmetical computation, or whether the efficient furnace door opened to the right or the left? Would you not want to know, first and last of all, how long a time his mind is completely on his job, and could this fact be determined by any other method than by finding out whether he was interested in anything more than drawing his pay? "Can you shovel coal?" is not nearly as important a question for such a man as "Are you antisocial?" The problem of fitting men to their jobs is far more a question of sentiment than it is of either skill or intelligence. *E*motion

study, not motion study, is the all-absorbing occupation of those who know industrial problems from the inside.

The physical conditions of the factory, store, and office are important items in industrial psychology. It is being more and more recognized that the way in which a building is lighted influences not only the eye of the worker, but also his whole attitude toward his work. Equally important are the problems of ventilation and sanitation, whose relations to the health of the worker are no more important than their effect upon his morale. In the same way the adjustment of the height of tables and counters to the height of the worker has wisely received no little study. And it will not be long before the cement floor, now so common in factories and stores, will have to be replaced by a less resistant material. For the human body is of such a consistency as to require, nay, demand, a yielding surface upon which to stand if it is to do its best work for any length of time. Even now men give up their jobs for no other reason than because they feel themselves wearing out on a cement floor. Moreover, sharp tools falling on such a floor are often ruined, and fine instruments are deprived of their accuracy, whereas the same tools and instruments falling on wood have an even chance of being used again. Even the harder woods are more elastic than cement, and consequently absorb many shocks that would otherwise be transmitted to the bones of the legs and the spine. In the solution of this problem applied physiology and mechanical engineering conflict. The cement floor is cheaper, and will not burn, neither does it need constant repairing; and although wood is for these reasons regarded as unsatisfactory, if it comes to

a choice between cement and men, the cement will have to go.

The adjustment of tools to workers is an important innovation in every line of industry. Dr. C. S. Myers, in his "Present-day Applications of Psychology," reports a study of shoveling. "Five hundred men who had previously employed a shovel of a constant size, whether for ashes, coal, iron ore, and the like, were experimented on to ascertain the optimal weight per shovel load for a good shoveler. The best average weight was found to be twenty-one pounds. Accordingly, shovels were made of different sizes, in proportion to the heaviness of the material shoveled, so that each shovel, whether full of coal, ash, or iron, weighed twenty-one pounds. This was the most important innovation, although others were at the same time carried out. The results were as follows: (1) The average amount shoveled per day increased nearly 270 per cent, from sixteen to fifty-nine tons per man; (2) 150 men could now perform what it took 500 men to perform under previous conditions; (3) the average earnings of the shovelers increased 60 per cent; (4) the cost to the management, after paying all extra expenses, was reduced by 50 per cent; and (5) there was no evidence of increased fatigue on the part of the shovelers."

The problem of fatigue is likewise receiving much profitable study at this time. The elimination of unnecessary noise is also being regarded as no more important than the determination of the best clothes in which to work. Clothes in which the best walking is done are now being distinguished from clothes in which the best work is done while the worker stands or sits. Dr. C. S. Myers thus speaks of the

question of enforced rest periods as an offset to fatigue:

"In the factory the importance of interpolating more frequent rest pauses is only just beginning to be realized. There can be no doubt that an unbroken morning or afternoon's work of four or more hours is economically unsound, and that the systematic introduction of rest pauses (together with the elimination of periods of slackness, needless movements, etc.) must lead to a vast improvement in quantity and quality of work. Let me exemplify this by quoting the results of a trench-digging competition during the present war between two companies. The officer of one company allowed his men to work uninterruptedly until their condition demanded a rest. The officer of the rival company divided his men into three sections, of which each section successively worked their utmost for five minutes and rested for ten. This systematic arrangement resulted in an easy win for his company. So, too, in a certain munition factory, the interpolation of a fifteen-minute rest in each hour is reported to have yielded a definite increase in the output of work, despite the initial objection of the men, who were being paid by piecework."

The direct application of psychology to industrial problems may be further illustrated in the case of teaching the beginner to perform some manual operation. Take, for example, some of the operations in a woodworking plant, such as running a buzz saw or operating a drill press. It is too often the case that the beginner is so confused by the noise and clatter about him that he neither sees nor hears exactly what his teacher is trying to show him; and it equally often occurs that the teacher is too much

accustomed to the shop to realize that a stranger is more or less confused and frightened by his new surroundings. Now a buzz saw is, of all simple machines, the most deceptive, and the beginner must treat it exactly as he would a loaded rifle—i. e., he must keep away from the line along which its energy is released. He may or may not be taught this the first day in the shop, but if he is not taught it carefully and repeatedly he can never be said to have learned to use a buzz saw properly. And unless the teacher repeats the original instructions every day for a few days, the chances are that the proper amount of respect—one is almost inclined to say reverence—for this machine will never be ingrained in the beginner. Indeed, every good mechanic periodically pauses and ponders the properties oı his tools, not only to save materials, but also to avert accidents.

Recently I had the occasion to observe one man show another how to operate a switch that started shop machinery in motion. The handle of the switch was to be pushed forward a few inches, held there until the machinery got well under way, and then it was to be forcibly pulled back across a much longer distance, and all at once. The novice tried it and failed; tried again and failed a second time simply because his attention had been so dominated by the sudden loud noise of the machinery that the teacher's verbal instructions as to the required motions were lost upon him. The louder sounds had occupied all of his motor outlets. It would have served the teacher's purpose better had he required his pupil to go through the required motions with a plain stick of wood before attempting to operate the switchboard.

"Safety first" is an expression that we hear today on every side, and employees are warned against all manner of accidents by means of placards, pamphlets, and even motion pictures. And while all this is in some cases effective, yet it seems that the safety of employees depends more upon how they are instructed during their first days in the factory than upon any other single thing. Foremen little realize how much they have become accommodated to their machines, as well as how little of their first instruction the novice thoroughly assimilates. Moreover, the beginner is often made to feel that it is wiser to look alert than to ask to have the instructions repeated, for many a foreman, through not being a good teacher, is impatient of ignorance. A clear first impression, as we said in the chapter on memory, is the most essential thing for the retention of any fact; and it is just such a clear first impression which can be counted on to stimulate men in the midst of danger to think of safety first. Placards, signs, and even pictures all get accommodated to and lose their tang. Moreover, the half-instructed man tends to make up for his deficiencies by dreaming that it will be the other fellow, and not himself, that will be hurt next. On the other hand, the fully instructed, and consequently alert, man is provided with the only means whereby to avert accidents both to himself and to others. The essential thing is thoroughly to establish a specific "action pattern" in all workers who have to do with dangerous machines, for without this neither safety can be maintained nor good work accomplished.

As an illustration of the application of psychology to certain problems of management, I shall quote from memory a story told me by an official in one

of the telephone companies of New England. A man whom he had employed and sent to work under one of his foremen was reported in a short time for that form of inefficiency known as laziness. The man was sent to another foreman, but within less than a week was again reported for the same offense, whereat he was transferred to a third department, only to be reported again for the same cause. The official who tells the story had employed the man because he had sized him up as being a capable worker under proper supervision, and, in order to test his judgment thoroughly, promptly transferred the man to a fourth department with instructions to the foreman in charge to report within a week how the man was getting along. Somewhat to his surprise, at the end of the week the foreman reported that the new man had made himself practically indispensable, was willing, obedient, and exceptionally handy at his work. Thereupon the official summarily called the other three foremen into his office and confronted them with their failure. "Moreover," he said, "you gentlemen have now made yourselves responsible for the discharge of at least a dozen men from your departments during the last year. Stiffen up! I hire no man in whom I disbelieve; it is your business to know a good man when you see him." For the official had sufficient insight into the mental make-up of these three foremen to know that they would condemn in advance to each other any workman with whom they could not get along. Of course no stranger could make headway against such a strong sentiment in his disfavor. And it will be observed that the official, in following this particular course, "left no loose ends hanging." It is the lack of such a "follow-up" system that is

responsible for most of the inharmony that springs up in industrial relations.

Let these examples suffice to illustrate the value of applying psychology to business. They are not the only examples, nor, to some people, will they be the most important applications. But it is plainly seen, even from this brief treatment of the subject, that the science which deals with man's mind deals also with every phase of his existence. Social problems, governmental problems, problems of law, of medicine, and of morals all have a necessary connection with the science of psychology. To be sure, not every such problem has a solution or is yet ripe for the one solution that would be required; but it is certain that wherever human relations are concerned an insight into psychology is the only means by which those relations can be understood or adjusted.

CHAPTER XXXVI

MENTAL HYGIENE

NO feature of our civilization is so striking as the contrast between our care of the body and our neglect of the mind. Our city streets are placarded with all sorts of signs that betoken how much human effort is devoted to the needs, ailments, and beautification of the human body, but scarcely anywhere hangs a sign announcing a similar devotion to our mental requirements. The grocer and butcher keep the stomach filled, the clothier and haberdasher help us keep out the cold, the physician prescribes for our stuffy heads and hardening livers, the dentist removes our teeth that ache, the chiropodist soothes our weary feet, while the hair specialist, the beauty doctor, and the manicurist struggle to make us as ravishing as nature will allow; but where are the signboards that proclaim "Associations Developed," "Attentions Prolonged," "Imaginations Enriched," "Reasoning Powers Rebuilt," or "Wills Fortified Against Discouragement"? It is true that one mental function, memory, has recently been marketed extensively, but where is the Doctor of the Soul who ventures to dispense the much-needed power to forget?

Nevertheless, such a lack of aids to mental soundness as we have mentioned is more apparent than real. For it will be clear to anyone who has read the preceding chapters intelligently that what is

called mental hygiene is in reality a branch of the hygiene of the body as a whole. This does not mean that to be well and to be intelligent are identical, for there are many human beings in good physical trim who are little more than walking vegetables so far as their mentality is concerned. All we mean by asserting that mental hygiene is a branch of the hygiene of the body as a whole is that the man who properly conserves his mental powers will take heed that his supply of physical energy is kept at a high level. For since all mental activity whatever is carried on by the nervous, muscular, and glandular mechanisms of the body—in other words, at the body's *expense*—it is essential that there be maintained an abundant margin of energy to make good the loss entailed by any excessive mental activity. From this, moreover, it is clear that all the aids to health and to physical relaxation which we mentioned in our opening paragraph are, when properly employed, equally potent factors of a sound mental hygiene. And while it is true that health does not guarantee mentality, it is equally true that the best thinker cannot be an unhealthy man.

Let us see how various defects in the functioning of the bodily organs impair the efficiency of that mechanism by which our mental activity is maintained. Dr. Percy Stiles in his book, "The Nervous System and Its Conservation," writes as follows of the effect of the disturbances of nutrition upon mentality: "The opinion is commonly held that many powerful personalities have been perverted by dyspepsia. This is said, for example, of Carlyle. Of course it is hard to say in such instances which is cause and which is effect. The indigestion may be the result of the inefficiency of a nervous system in

which pessimism is a congenital characteristic. But whether despondency and cynicism are primary or secondary, there is no reasonable doubt that when they are once established they continue to impair the digestive capacity, and the alimentary trouble tends to intensify the nervous deficiency."

Dr. Stiles continues: "The reaction of a disordered stomach upon the brain is not solely by means of nerve impulses such as result in general sensation. It is now believed that the influence exerted is largely due to chemical products originating in abnormal fermentation processes in the canal. Entering the blood, these deleterious compounds are borne to all parts of the body, but they have an especially marked effect upon the central nervous system. The condition in which these poisons are circulated and become productive of mischief is spoken of as auto-intoxication. It is favored by overeating, especially of nitrogenous foods (meats, eggs, and legumes). But it may develop also when the diet is scanty, for it has become clear in recent times that underfeeding may so enfeeble the reactions of the organs of digestion that they do not care for the food so well as they would for a larger and more stimulating ration." The "spare diet" which is traditionally associated with the scholar has, therefore, no justification at the hands of experts in health and nutrition.

To continue from the same author: "Auto-intoxication is frequently associated with anemia, and this condition—a diminution of the oxygen-carrying substance in the blood—always threatens injury to the nervous system. It implies limited endurance in every pursuit. Just how the anemia of auto-intoxication is caused is not always plain. In some cases it is probably due to the continuous formation in

the intestine of a poison which is destructive to the red corpuscles."

Nervous impairment may, however, be caused by many other things than over- or under-eating. An insufficient supply of oxygen occasioned by shallow breathing, together with a residue of poisoned air left for days in the bottom of the lungs, may produce the same result. Brain workers all too often suffer from these defects. The oxygen supply, as well as the digestion, may be hindered in those who have acquired a bent-over and cramped study posture. Often such persons show in the tensions of their neck and facial muscles the extent to which they have attempted to compensate for their fatigue by calling on energies which should be kept always in reserve. And while many such a person does not feel in the slightest degree the extent to which his nervous system is overworked, the impairment of his mental powers shows none the less in what he produces. For often the warning of ill which pain is supposed to furnish does not come until it is much too late to take the hints it provides. Occupational postures are, indeed, often signs of the permanent enfeeblement of the intellect. For to maintain such a posture means that the muscles have become chronically tense, and this condition implies that some of the nervous energy is being used to perform nonproductive work. And since the energy which goes to the upkeep of the mind is normally drawn from what is left over after the vital processes have taken their share, all such expenditures incurred by the maintenance of occupational postures are necessarily wasteful.

Herein lies the great value of right habits of physical exercise and relaxation to restore to even uncon-

sciously overworked muscles their normal tonus and resiliency. There would be less pessimism in the world and fewer stubborn, hot-headed, and bigoted people if the mechanics of muscle were understood and applied to the needs of the individual. For one of the greatest drawbacks to mental efficiency is the muscle-bound condition from which the great majority of mankind suffers. Such a defect can be observed even in the half-grown youth who shows by his lack of pep and muscular elasticity the beginnings of that narrow-mindedness which will eventually encompass his middle years. You see him already limiting his mind by the exclusive imitation of some one of his elders. Thus it is that many a person reaches maturity with fixed habits of inflexibility from which he can never wholly extricate himself. Now such a condition, as we have already hinted in the chapters on Habit and Will, is equivalent to the loss of the use of half his body. And the only remedy for such an error, if, indeed, it be not too late to prescribe it, is the practical application of the principles of the mechanics of muscle by some one wise enough to diagnose the precise needs of the individual and supervise the proper regimen. Thus we may lay it down as a sort of rule that the only physical exercise worthy of the name is the kind which, while stimulating the vital functions, also relaxes the chronic tensions attendant upon our occupational postures. As for relaxation, the right word is briefly said. He who cannot loaf and become of himself forgetful of the day's work after it is done is lacking in some resources which even the beasts of the field possess.

The impairment of mental functions can be traced to numerous other causes than those we have men-

tioned, many of which ordinarily go unnoticed. "Defective teeth afford an example. Many troubles associated with the feet, such as corns, broken arches, or even badly fitted shoes, belong in the same class. Nasal obstructions may have the same influence. Surgical operations for the relief of such conditions may bring about what is little less than a regeneration of the character of the individual. Among temporary causes of imperfectly realized nervous strain may be mentioned the wearing of orthodontia appliances. Children obliged to submit to these instruments may not complain of great distress, but they are likely to be made irritable and tired by the constant wear and tear." It would be an interesting study to record the extent to which people suffering from the neglect of their teeth and feet seek to compensate for this carelessness by plunging themselves into distracting excitements of various sorts. There are thousands of persons chronically under par because of a dull, persistent toothache, who apparently regard it more desirable to crowd their lives full of social intoxications rather than to spend a few hours with a competent dentist. And one need only to watch the heels, ankles, and manner of walking of half of the pedestrians on the street to observe that very few of them know what it is to be unconscious of their feet. Many of them literally totter as they walk. It is scarcely to be expected that such people are either easy to live with or fully equipped to attend to their work.

Neglect or abuse of the eyes is an equally potent cause of mental inefficiency. Many people of otherwise satisfactory intelligence abuse their eyes every night by direct or insufficient light, or by reading fine print in the street car where the vibration causes

eyestrain by constantly shifting out of focus the page they are reading. A curious fact connected with vision is that the overuse of the eyes does not always result in discomforts to the eye muscles themselves. On the contrary, the pain which would normally be felt in that locality is often referred by means of the sympathetic system to other parts of the body. Behan, in his excellent volume on "Pain," cites a true account of a person complaining of appendicitis pains which were nothing but "referred" pains originating in eyestrain. And the curious thing about the type of person suffering from such a condition is that he is usually very hard to convince of the true cause of his ailment. So greatly has his mental acumen been impaired by his long self-neglect that he will be very loath to attribute his appendicitis pain to its "ignoble and commonplace cause." Indeed, "he is half-anxious to find grounds for the belief that he is suffering from a mortal disease," and he prefers the idea of appendicitis to eyestrain. The reader will recognize that such stubbornness is due to chronic muscular tensions too long left unrelieved. It is also in such cases as the above where "faith healing" is found effective. The patient who is willing to have a worse malady than that from which he really suffers is also vain enough to claim that only superhuman agencies can cure him.

Another cause of mental deficiency is the needless excitement that is often indulged in when the blood is required for digestion. Not only does this refer to heated arguments and antipathies needlessly indulged in at the breakfast and dinner tables, but also to such things as the "quick-lunch" habit, and to the neglect of relaxation after meals. The blood in the body is automatically concentrated in the digestive

apparatus during and immediately after feeding, and hence any excitement or mental effort which requires the sending of extra blood to the brain impairs the alimentary functions. Often this impairment, upon becoming habitual, reacts upon the organism by inhibiting the appetite during meals, the final result of which is to cause the person to become undernourished, thereby reducing both his physical endurance and his powers of continuous mental effort. Many of our obituary notices, in order properly to indicate the cause of death, should include mention of the extent to which the deceased neglected the simplest rules of right living. And it might not be amiss to chisel on some gravestones such an inscription as the following:

HERE LIES

A MAN

WHO WOULD STILL BE ERECT AND LIVING

HAD HE NOT

BY HABITUAL BICKERING AT THE BREAKFAST TABLE

ROBBED HIS STOMACH AND INTESTINES

OF THE LIFE-MAINTAINING BLOOD

Let us now turn from these physiological hindrances to efficiency to a consideration of certain psychological devices for improving our mental organization.

The first of these is the striking of a fair balance between vocations and avocations. For while regular habits and routine serve the valuable purpose of

making us useful and serviceable to many people at the same time, avocational interests serve the equally valuable purpose of making us a constant source of interest to ourselves when we are alone. Emerson complained that he saw so few people whose life was broader than their occupations. "You see a hand, a foot, and an ear," he said, "but never a man." No doubt the nicest balance is very hard to strike between work and play. The philosopher Kant is the classical example of excess on the professional side. "He never perspired nor laughed," wrote Heine. On the other hand, the modern store and factory contains dozens of operatives whose sole permanent interest appears to be the pursuit of the newest thrill on the dance floor and the movie screen. Now both the "grind" and the "thrill hunter" are equally narrow-minded. And they are narrow-minded solely because they restrict their activities to one single type. The cure for both of these defects appears to require the same treatment, namely, to avoid being exclusively dominated by any one interest, whether vocational or avocational. For this will serve not only to balance the body's energies by releasing them in a welcome variety of ways, but it will also result, by adding to one's list of friends, in enlarging the environment. And I think it is admitted by most employers of labor that the man who has abilities beyond those for which he is paid is better equipped to do that work by which he earns his living.

A second valuable factor in mental hygiene is the cultivation of a wholesale economy in mental effort. The motto, "Let your head save your heels," is based upon the soundest principles of physiological and psychological science. For since all mental functions

whatsoever are maintained at the expense of the body's energies, it is essential that the expenditure of these energies, if it must be lavish, be not therefore prodigal. Now the brain is so constructed as to coordinate—that is, to bring into close cooperation—every form of activity we manifest. Its connector neurones communicate with every motor pathway in the whole response apparatus. When, therefore, the head does not save the heels—if a vast amount of nervous energy is expended where a smaller quantity would have sufficed—the fundamental principle of mental economy is violated. James J. Hill was accustomed to say that a man's success and character could be predicted from the proportion of his earnings that he saved; is it not equally the case that the index of a man's intelligence can be determined from the amount of nervous energy which he conserves? For the motto, "Let your head save your heels," means not only that it is wisdom to think in order to save one's steps, but also that it is imperative to think well *once* in order to save oneself the effort of thinking ten times in a random fashion.

Let us then see how such a wise conservation of mental effort is actually attained. To this end we shall not lay down any rules or obtrude any unsought advice, lest the reader, being negatively suggestible, should resist it. Rather let us simply describe some of the characteristics of a good mind, drawn from the actual observation of real people:

1. The good mind begins the day by systematically planning its work. To be sure, in many cases this cannot be done with any degree of exactness, as, for example, in the case of the traveler whose itinerary is uncertain, or in the large family where

accidents and novelties of all sorts are bound to interrupt the expected course of events. But even so it is possible for a man to be *in utrumque paratus*—that is, ready even for emergencies. For he can say: "If this particular work I plan to do is interrupted, I can temporarily change to that," and thus proceed to supervise his various tasks in order to be able later to mortise and dovetail them into one another. And while a day full of such interruptions may not be the most productive, it is nevertheless certain that the man who previses even thus far will save more effort than he who stands helpless at the slightest surprise which befalls him.

2. The good mind conserves its energy by changing its memory from a rag bag of disconnected facts into a system of related things. It has no detached ideas. It gives full time to obtain clear first impressions, and is not so busy as to let that which is important slip away through being inaccurately recorded. Neither does the good mind manifest that particularly trying vanity known as "complete recall" when it reports recollected events to other people. It cites only the essential points, trusting to the listener's imagination to fill in the tedious details.

3. Such a mind as we are describing, furthermore, wastes no effort in concentration until it has organized a permanent and constructive sentiment toward the work which it is set to do. Neither does it waste any time in improvisation, or in "beginning doubtfully and far away," but it *attacks* problems directly, rather than vaguely hopes that they will solve themselves. When in doubt it experiments instead of making futile appeals to an abstract principle of reason. Neither does it aspire to be a "world beater," but it is quite content to be engaged in any produc-

tive labor which enriches the immediate environment and broadens the all-important finite horizon. Its efforts *are*, and do not have to be, concentrated on the work in hand.

4. Clear language is a source of economy on the part of those who manifest a good mind. They realize that words are the most important instruments for conveying ideas, and the most essential means for dealing effectively with their fellows. Hence they seek out and learn those words whose meaning is the most precise, and they store their minds with them with the same care as a warrior stocks his arsenal with the most efficient weapons he can obtain. Their language is neither an uncertain broth of disconnected syllables, nor a tiresome repetition of the same cant phrases. They come to the point directly. They do not leave one in doubt as to what they mean, and their future actions can be predicted from their words.

5. Such persons also conserve energy by analyzing the cause of their mistakes rather than waste energy by indulging in a self-pitying reminiscence of their blunders. Instead of becoming introspective over their errors, or treating them with a misapplied indulgence, they improve their technique so that the same faults will not occur again. As they analyze situations, so they analyze their fellow men. But their analysis is not equivalent to dissection, neither is it a malicious search for defects. For they weigh and choose, prefer and discount solely in order to attain the power to evaluate; while the continuous practice of such analysis corrects its own mistakes.

6. And, finally, he who conserves his energy has a sufficient margin with which to balance his mental books at the close of the day. No matter what

struggles he has undergone, or how far he has been thrown temporarily out of balance by his contact with his fellow men, his psychological center of gravity returns to his own body when ne is alone and preparing for sleep. No matter how he is working—by the day, the week, the month, the year, or the lifetime—his day has accomplished its fraction of his purposes. Having satisfied his normal obligations, he does not have to lie awake devising unusually potent autosuggestions in order to rid himself of aggravating inhibitions. He does not imagine difficulties which never exist, but saves all his energy for constructive purposes. In all this, moreover, he manifests that combination of qualities which mark the man whose brain produces secretions rather than excretions.

It is not a difficult matter to put into practice the general principles of mental hygiene, provided there are not too many self-imposed barriers in the way. And it is usually the case that the most stubborn barriers to the conservation of nervous energy are neither ill health nor lack of technical education, but rather ill-chosen acquaintances and one's own suppressions. For while both the diseased and the poorly educated man are out of the race as far as mental excellence is concerned, he who is entangled by unprofitable acquaintances to whom he must constantly capitulate, and he whose subconscious mind is ever reverberating with the din of an unconscious conflict are in a far worse predicament than either the sick or the illiterate.

Hence one of the first things to be done by him who wishes to profit by a knowledge of applied psychology is to analyze his acquaintanceships to see how many are merely entangling alliances that yield

no profit to either of the persons involved. Of course, many people will find even this simple step impossible to take, to say nothing of the next step, which consists of the dissolution of all such unprofitable social partnerships; fearing, as they aver, that if they lose the acquaintances they now possess, they may not be able to replace them by other and better ones. But this argument plainly rests upon something like the self-pitying sentiment. And this unprofitable sentiment arises because such people have so narrowed and restricted their responses to a small patch of humanity that they have lost every vestige of flexibility they ever possessed. But it is certain that the conservation of human energy cannot be practiced unless first the self-imposed hindrance of unprofitable acquaintances be removed. And let no person burdened with such bonds fear that to relax them will result in any loss of valuable prestige. On the contrary, the taking of such a decided step will of itself provide the means for the discovery of such comradeships as will result in that equable give-and-take which marks all permanent and profitable intimacies.

The problem of getting rid of one's suppressions is, perhaps, a far more difficult matter. For since ourselves are the last persons with whom we become thoroughly acquainted, it is often extremely difficult to know what hindrances to the economy of our energies we are continually erecting within our own organic interior. Nevertheless, if we can learn to take our fears, anxieties, and jealousies, our obsequiousness, our antisocial tendencies, and the intentions we constantly fail to put into action as cues, it will be possible to find out just where our largest waste of effort takes place. To this end,

also, the frank criticism of other people, especially of those who have already worked out most of their own ape and tiger, will be found invaluable. And while this particular problem is the longest and most enduring of life, as well as the one for which all too many easy solutions have been set forth by the stargazing mystics, he who attacks it directly and without a qualm may eventually attain that combination of flexibility, frankness, and steadfastness of purpose which among the most enlightened goes by the name of a soul.